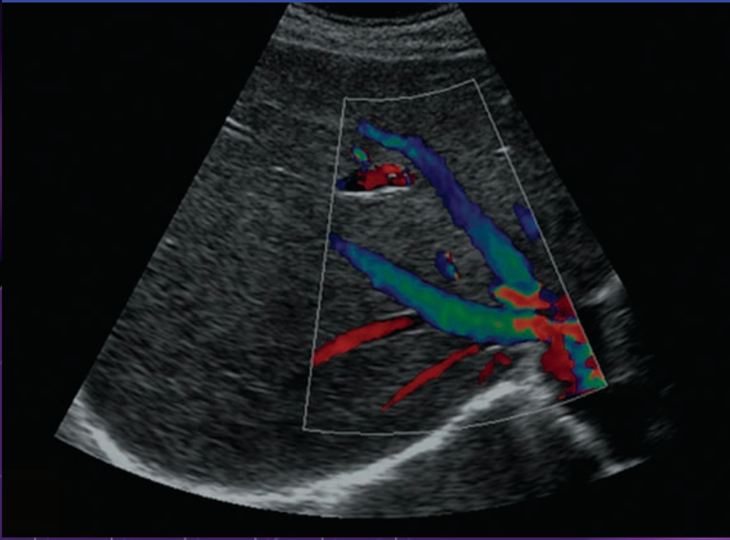
Emergency Medicine Sonography

POCKET GUIDE

to Sonographic Anatomy and Pathology



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to Sonographic Anatomy and Pathology

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CONTENTS

Acknowledgments ix
Introduction xi

Chapter 1: Ultrasound Nomenclature, Image Orientation, and Basic Instrumentation 1
Cynthia Silkowski

Ultrasound Nomenclature 1
Ultrasound Texture 4
Ultrasound Artifacts 4
Ultrasound Description of Masses 9
Ultrasound Sectional Views 12
Sectional Views and Image Orientation 12
Image Recording 23
Technical Points 23
Summary 24

Chapter 2: The Liver 25
Dunstan Abraham

Normal Sonographic Anatomy 25
Liver Pathology 31

Chapter 3: The Gallbladder and Bile Ducts 47
Dunstan Abraham

Normal Sonographic Anatomy 47
Gallbladder Pathology 47

Chapter 4: The Pancreas 71
Dunstan Abraham

Normal Sonographic Anatomy 71
Pancreatic Pathology 71

Chapter 5: The Abdominal Aorta and Inferior Vena Cava 84
Dunstan Abraham

Normal Sonographic Anatomy 84
Inferior Vena Cava 84
Major Distinguishing Features Between Aorta and Inferior Vena Cava on Sonography 84
Pathology 85

Chapter 6: The Kidneys and Urinary Bladder 92
Dunstan Abraham

The Kidneys 92
Renal Pathology 96
The Urinary Bladder 118
Bladder Pathology 118

Chapter 7: The Gastrointestinal System . . .129
Dunstan Abraham

Normal Bowel 129
Normal Appendix 130
Pathology 131

Chapter 8: The Spleen and Lymph Nodes . .136
Dunstan Abraham

Normal Sonography of the Spleen 136
Splenic Pathology 136
Malignant Tumors 143
Lymph Nodes 144

Chapter 9: Blunt Abdominal Trauma 147
Dunstan Abraham

Complications of Blunt Abdominal Trauma Seen on Sonography 147
Sonographic Findings in Blunt Abdominal Trauma . . .147

Chapter 10: The Scrotum and Testes 157
Dunstan Abraham

Normal Sonography 157
Head of Epididymis 157
Body and Tail of Epididymis .157
Appendix Testis 157
Vasculature 157
Pathology 160

Chapter 11: Lower Extremity Pathology . . .179
Kalani Fernando and Dunstan Abraham

Popliteal Fossa Cyst (Baker's Cyst) 179
Popliteal Artery Aneurysm 179
Calf Hematomas and Abscesses 179
Cellulitis 179
Pseudoaneurysms 179
Foreign Bodies 180

Chapter 12: Fluid Collections and Ultrasound Guided Procedures 183
Kalani Fernando and Dunstan Abraham

Fluid Collections 183
Ultrasound-Guided Procedures 183
Summary 186

Chapter 13: The Uterus 188
Cynthia Silkowski

Normal Sonography of the Uterus 188
Measurement of the Endometrium 191
The Menstrual Cycle—Sonographic Appearances of Endometrium 191
Postmenopausal Endometrium—Asymptomatic Female 193
Uterine Location and Positions 193
Common Congenital Variations Seen on Ultrasound 193

Pathology .197
Summary .214

Chapter 14: The Ovaries and Fallopian Tubes (Adnexa) .215
Cynthia Silkowski

Normal Sonography of the Ovaries .215
Pathology .215
Ovarian Torsion .234
Fallopian Tubes .238
Pelvic Inflammatory Disease .239
Endometriosis .240
Nongynecological Pelvic Masses .243
Summary .245

Chapter 15: First Trimester Normal and Abnormal Pregnancy .247
Charles Odwin

Sonographic Visualization of Normal Early Pregnancy .247
Multiple Pregnancies .258
Abnormal First Trimester Pregnancy .259
Ectopic Pregnancy .264
Summary .276

Suggested Reading List .279
Index .281

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INTRODUCTION

The widespread availability of ultrasound technology in emergency medicine departments has enabled practitioners to evaluate critical patients more rapidly.

Emergent conditions, such as ectopic pregnancy and hemoperitoneum, can be diagnosed earlier so that decisions regarding management can be made without significant delay.

Obtaining the necessary technical and diagnostics skills to perform sonographic procedures and to interpret these images, however, can be both difficult and challenging. This is especially true for practitioners who lack formal training in this imaging modality.

This pocket guide is ideal for practitioners performing sonography who have at least a basic level of knowledge and technical skills. It covers normal sonographic anatomy in some detail as well as a spectrum of pathologies seen on sonography. The information is presented in a bulleted format and is supplemented with well-illustrated sonographic images. It is user friendly, and its small size makes it a useful source of reference at the bedside.

Although the book will be of great benefit to emergency medicine practitioners, others such as trauma specialists, residents, sonographers, and students may similarly find it quite helpful in clinical practice.

Chapter 1: Ultrasound Nomenclature, Image Orientation, and Basic Instrumentation

CYNTHIA SILKOWSKI

Ultrasound waves are sound waves that have a frequency exceeding 20,000 Hz. When sound waves are transmitted into the body, they interact with tissues and become attenuated (reduction of signal strength) by absorption, scattering, and beam divergence. Reflected sound waves (echoes) are displayed on an image as varying shades of gray (gray scale) relative to their intensity and are dependent on the number of binary digits that can be stored in the digital memory of the equipment.

Echoes are created when emitted sound waves encounter tissues with an acoustic mismatch. This causes some sound waves to continue traveling and others to be reflected back to the transducer. These reflected echoes are then converted into an image that is displayed on a monitor.

Ultrasound Nomenclature

See Exhibit 1.1

- Echogenic: the ability of a structure to produce echoes
- Anechoic: no echoes and sonolucent—appears black on ultrasound (Figure 1-1)
- Hypoechoic: less reflective and low amount of echoes when compared with neighboring structures, appears as varying shades of darker gray (Figure 1-2)
- Hyperechoic: highly reflective and echo rich when compared with neighboring structures, appears as varying shades of lighter gray; the term echogenic is often used interchangeably (Figure 1-3)
- Isoechoic: having similar echogenicity to a neighboring structure (Figure 1-3)

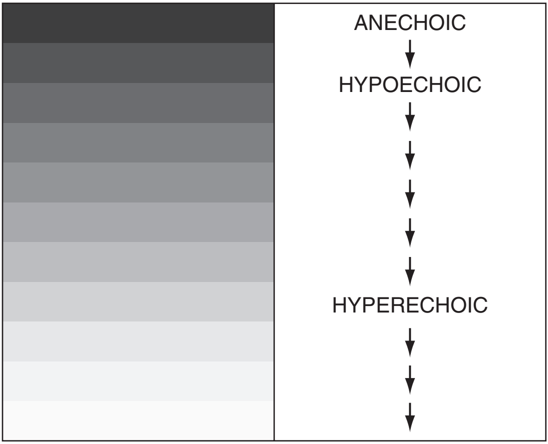


Exhibit 1-1 Ultrasound nomenclature.

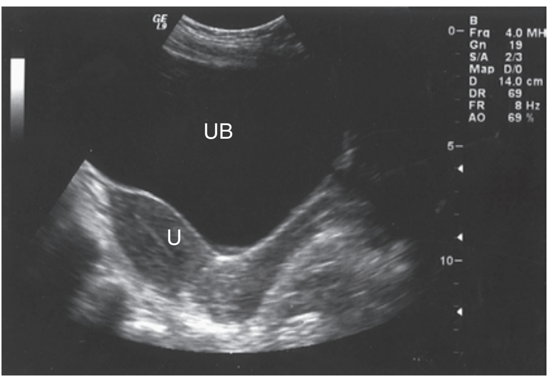


Figure 1-1 Anechoic. A transabdominal sagittal image of the female pelvis demonstrating the anechoic distended urinary bladder (UB) anterior to the uterus (U). Note the lack of echoes within the urinary bladder since it is filled with urine.

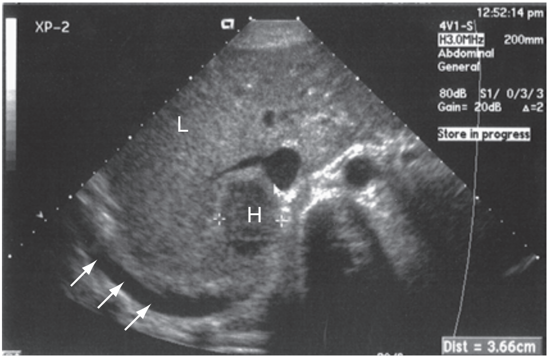


Figure 1-2 Hypoechoic. A transabdominal transverse image of the liver (L) demonstrating a hypoechoic (H) mass within the right lobe of the liver. Also, note the anechoic fluid (arrows) representing a right-sided pleural effusion.

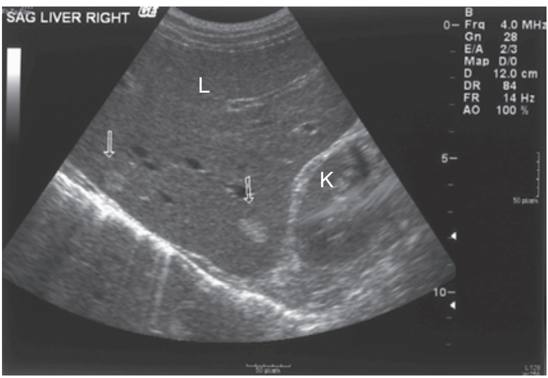


Figure 1-3 Hyperechoic and isoechoic. A transabdominal sagittal image of the right upper quadrant. The liver (L) contains two areas (arrows) that are hyperechoic when compared with the rest of the moderate echogenicity of the liver parenchyma. The kidney (K) is isoechoic to the liver.

Ultrasound Texture

- Homogeneous: organ parenchyma is uniform in echogenicity (Figure 1-4).
- Inhomogeneous or heterogeneous: organ parenchyma is not uniform in echogenicity (Figure 1-5).

Ultrasound Artifacts

Artifacts may be caused by the following:

- Ultrasound waves interacting with tissue
- Machine malfunction
- Improper operation of machine (such as control settings)
- Motion of the patient (such as breathing)

Common Ultrasound Artifacts

- Reverberation (ring down): This occurs when sound travels with minimal to no attenuation

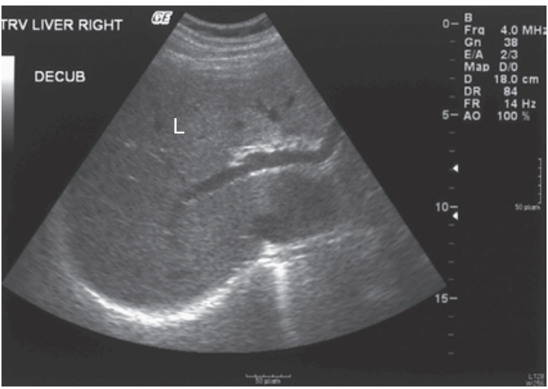


Figure 1-4 Homogeneous. A transabdominal transverse image of the liver (L) demonstrating the normal uniform texture of the liver. Anechoic structures within the liver represent vessels and ducts.

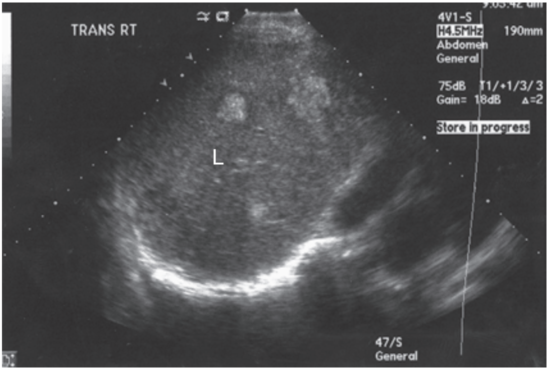


Figure 1-5 Inhomogeneous. A transabdominal transverse image of the right lobe of the liver (L). Note the nonuniformed appearance of the liver parenchyma representing metastatic liver disease.

through a fluid-filled structure. It is displayed as multiple parallel echogenic lines equidistant from each other. They become fainter as sound travels deeper into the structure (such as the anterior region of a filled urinary bladder or large cystic mass). Reverberation can mimic solid elements in an otherwise cystic organ or a mass (Figure 1-6). Changing the scanning angle of approach may resolve this artifact.

- Comet tail: This is a type of reverberation artifact. It appears as a dense, tapering trail of echoes distal to a strongly reflecting structure. Metallic objects (such as surgical clips and bullet fragments) and adenomyomatosis of the gallbladder may produce comet-tail artifacts (Figure 1-7).
- Acoustic enhancement (posterior enhancement, good through transmission): This is seen as a hyperechoic pattern posterior to a poorly or nonattenuating structure or mass (e.g., a cyst).

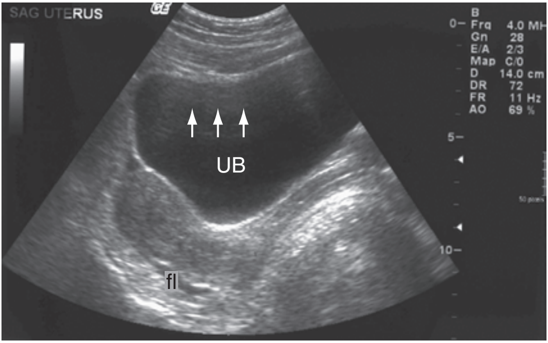


Figure 1-6 Reverberation artifact. A transabdominal sagittal image of the female pelvis demonstrating an anechoic distended urinary bladder (UB) with anterior reverberation (arrows) artifacts. Note the minimal amount of fluid (fl) in the posterior cul-de-sac posterior to the uterus (U).

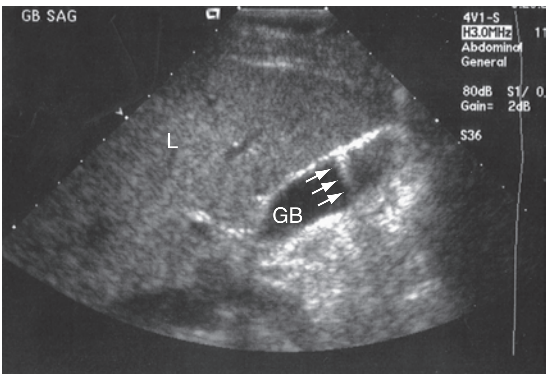


Figure 1-7 Comet-tail. Transabdominal sagittal image of the gallbladder (GB) with a dense tapering trail of echoes posterior to a strongly reflecting structure (arrows). Liver (L).

Echoes posterior to a cyst look "brighter" than adjacent echoes (Figure 1-8).

- Attenuation: This is the lack of sound transmission through a mass. It generally indicates a solid internal consistency (Figure 1-9).
- Shadowing: This appears as a hypoechoic pattern posterior to highly attenuating structures (e.g., calcifications such as gallstones or plaque, bone, and air). Echoes posterior to these structures look "darker" (a reduction in the amplitude of the echoes) than adjacent echoes (Figure 1-10). Shadowing is described as "clean" or "dirty." "Clean" shadows present posterior to calcifications, bone, plaque, and dense structures such as intrauterine contraceptive devices. Shadows from these structures are sharply demarcated. Shadows posterior to air or bowel are referred to as "dirty" shadows, and they lack the clean, sharp side edges.

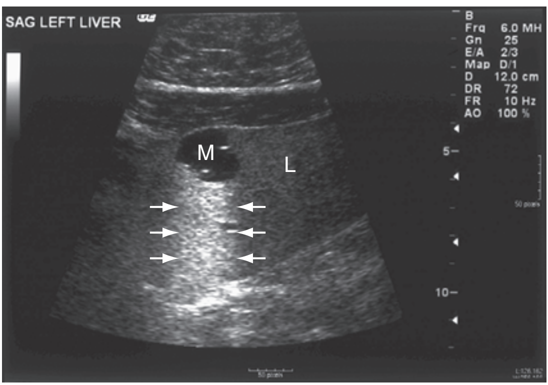


Figure 1-8 Enhancement artifact. A transabdominal sagittal image of the left lobe of the liver (L) demonstrating a cystic mass (M). The liver parenchyma posterior to the cyst is enhanced (arrows) because of the lack of sound attenuation.

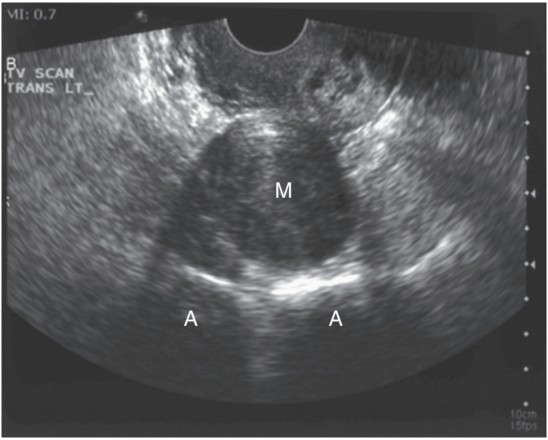


Figure 1-9 Attenuation artifact. A transvaginal coronal image demonstrating a hypoechoic solid mass (M). Note the absence of sound transmission posterior to the mass caused by attenuation (A) of sound waves.

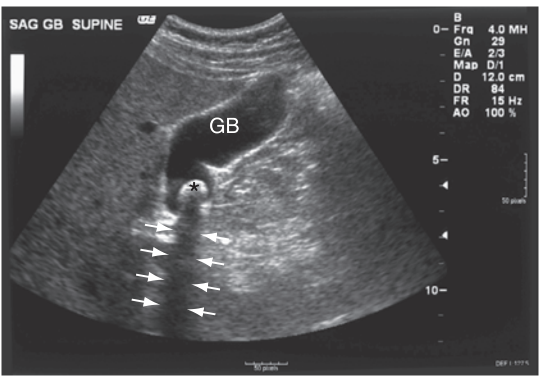


Figure 1-10 Shadowing artifact. Transabdominal sagittal image demonstrating the gallbladder (GB) with an echogenic focal area (*) representing a gallstone casting a posterior acoustic shadowing (arrows).

Air-filled bowel loops near the gallbladder can mimic gallstones (see Chapter 3).

- Slice thickness artifact: This occurs when a fluid structure lies adjacent to a soft-tissue structure. The ultrasound beam strikes both simultaneously, producing low-level echoes in the fluid structure. These low-level echoes can be mistaken for pathology. Changing the scanning angle of approach can resolve this problem.

Ultrasound Description of Masses

Simple Cyst

- Completely anechoic, smooth walled, with posterior enhancement
- Reverberation may be seen on the anterior wall of the cyst (Figure 1-11).

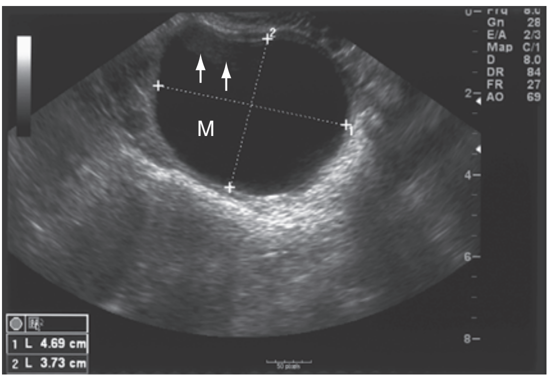


Figure 1-11 Simple cyst. A transabdominal sagittal image of a female pelvis. A unilocular, anechoic, smooth-walled mass (M) with posterior enhancement is demonstrated that meets the criteria for a simple cyst. Note the minimal amount of reverberation artifact (arrows) on the anterior aspect of the cyst similar to what is visualized in a distended urinary bladder.

Complex Cyst

- Anechoic, smooth walled, with posterior enhancement
- Septations that appear as echogenic hair-like strands within mass (Figure 1-12)
- Multilocular compartments (cluster of cysts) (Figure 1-13)
- Internal low-level echoes that may indicate hemorrhage or infection (Figure 1-14)
- Fluid-fluid layers that may represent blood, fluid, or fat layers
- Calcification that appears as highly reflective echoes (hyperechoic) with posterior shadowing

Solid Mass

- Homogeneous or inhomogeneous
- Hypoechoic to hyperechoic (Figure 1-15)
- May attenuate sound partially or completely

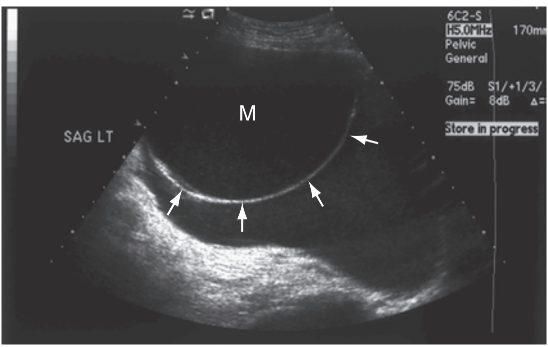


Figure 1-12 Complex Cyst. A transabdominal sagittal image of the left adnexa of a female demonstrating a large cystic mass (M) containing a thin, echogenic, hair-like structure (arrows). This is consistent with a septation in a benign complex cyst.

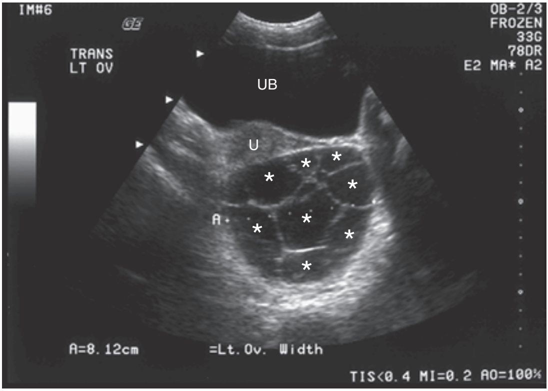


Figure 1-13 Complex Cyst. A transabdominal transverse image of the left ovary demonstrates a large cystic mass with multiple loculations/compartments (*). Note the appearance, which looks like a cluster of cysts. This is characteristic of a multilocular cyst due to the absence of solid components and absence of irregularities. Urinary bladder (UB), uterus (U).

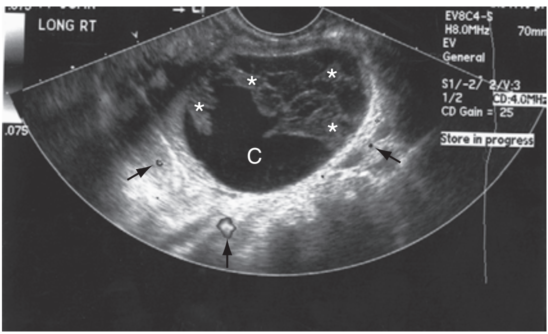


Figure 1-14 Complex cyst. A transvaginal sagittal image of the right adnexa in a female patient demonstrating a cyst (C) containing internal solid echogenic components representing hemorrhage (*). Echogenic hemorrhage within a cystic mass may mimic a malignant tumor. Doppler may be able to detect internal vascularity, which is frequently seen in malignant tumors. Note the presence of Doppler signals outside the cyst (arrows).

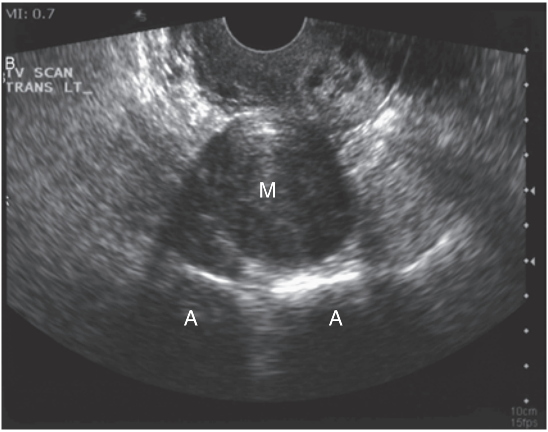


Figure 1-15 Solid mass. A transvaginal coronal image demonstrating a hypoechoic solid mass (M), which is inhomogeneous and has partial sound attenuation (A).

- May contain anechoic or hypoechoic areas within the solid mass representing necrotic changes
- Posterior enhancement that may be seen when necrotic changes occur

Ultrasound Sectional Views

- Sagittal plane (longitudinal)—obtained using either an anterior or posterior approach
- Transverse plane (axial)—obtained using an anterior, posterior, or lateral approach
- Coronal plane (sagittal or transverse)—obtained using a lateral approach

Sectional Views and Image Orientation

See Exhibit 1.2

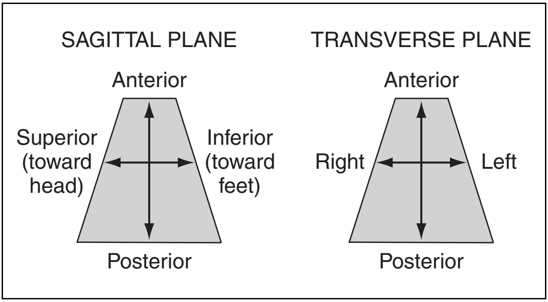


Exhibit 1-2 Sagittal plane and transverse plane.

Instrumentation

It is beyond the scope of this book to discuss the technical aspects of scanning in detail; however, this section briefly discusses some of the most frequently used functions of the ultrasound machine. It is recommended that practitioners learn the different capabilities of their own equipment to optimize image quality and diagnosis.

- Keyboard: various capabilities as provided by manufacturer
- Overall gain control: used to amplify all received signals equally (Figure 1-16A–C)
- Time gain compensation: used to "fine tune" attenuated signals
    - Near and far gains: These controls are used to equalize the differences in echoes received from various depths as they are displayed on the screen (Figure 1-16D–E). When compensating for sound attenuation, the near to far gain controls (usually slide pods) should be gradually increased.

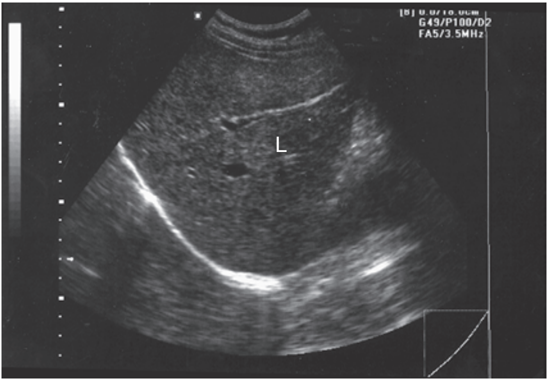


Figure 1-16A Time gain compensation (TGC) and overall gain settings affecting the image quality of the liver (L). Transabdominal sagittal images of the liver. (A) TGC with proper gain settings. The homogeneous liver with midlevel echoes is demonstrated. Note the intensity of the echoes is the same in the anterior, mid, and posterior regions of the liver.

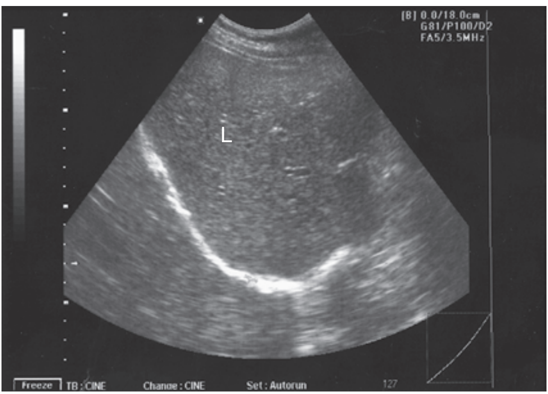


Figure 1-16B (B) TGC with overall gain greatly increased. Note the echogenicity of the liver parenchyma, which is hyperechoic and can mimic liver pathology such as fatty liver disease.

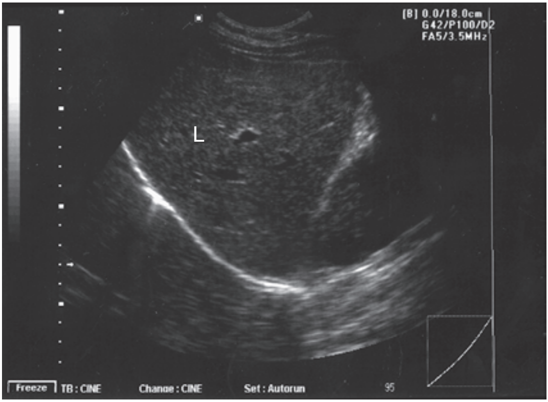


Figure 1-16C (C) TGC with overall gain greatly decreased. The liver appears to be hypoechoic compared with its normal echogenicity as a result of decreasing the overall gain setting too much. This may cause poor visualization of liver parenchyma, which could result in a missed diagnosis.

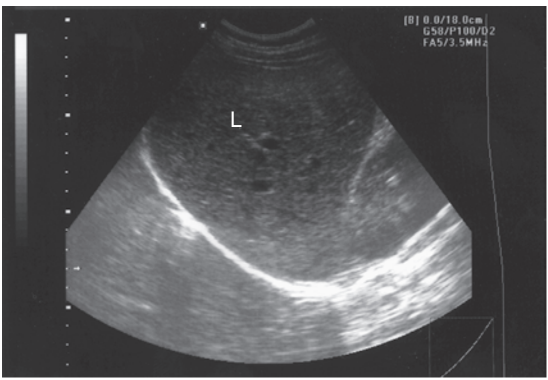


Figure 1-16D (D) TGC with far gain greatly increased. There is increased echogenicity in the posterior aspect of the liver, resulting from improper far gain settings. Small echogenic masses may be missed in this area.

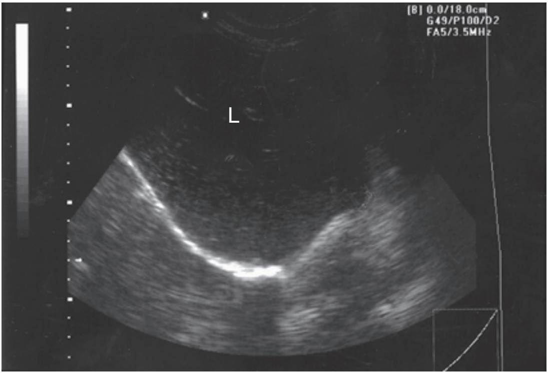


Figure 1-16E (E) TGC with near gain greatly decreased. The anterior aspect of the liver is poorly visualized because of the loss of echoes in the near field. Decreasing the near gain can result in missed pathology.

- Depth: This control is used to adjust the size of the image so that organs and adjacent structures or regions of interest are equally well visualized (Figure 1-17A–C).
- Focal point(s): A control that has one or more toggle buttons. This allows the operator to choose the level at which the ultrasound beam is focused to increase the resolution at a specific point or points. This control should be set at the most posterior aspect of the organ or structure being imaged (Figure 1-18A–C).
- Failure to properly adjust the gain control and/or poor placement of focal point during scanning may result in suboptimal image quality and misdiagnosis.

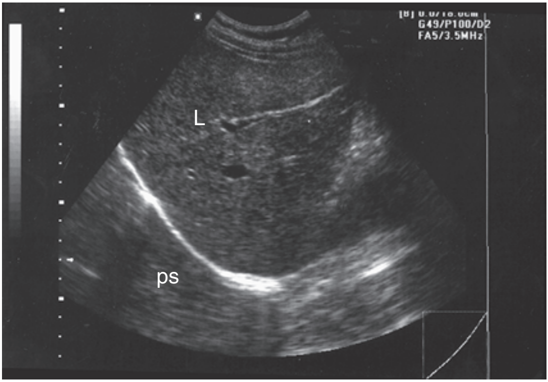


Figure 1-17A Depth adjustments affecting image size. Transabdominal sagittal images of the liver (L). (A) The correct depth control for this patient was at 18 cm. This allows the posterior aspect of the liver and the pleural space (ps) to be evaluated.

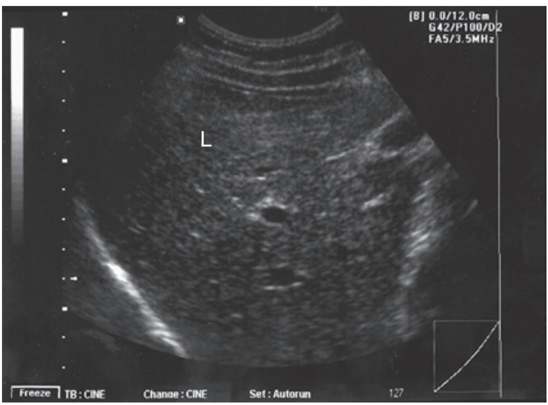


Figure 1-17B (B) The 12-cm depth is too shallow. The posterior aspect of the liver and pleural space was not demonstrated and therefore cannot be evaluated.

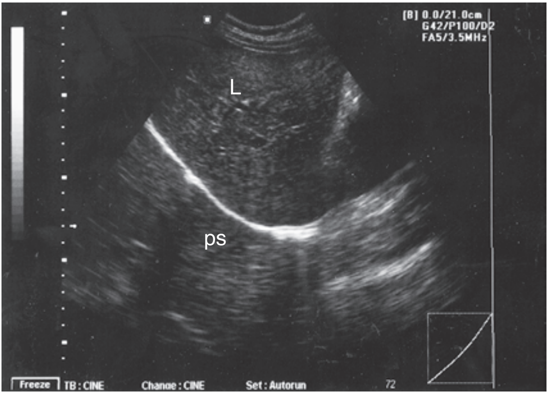


Figure 1-17C (C) The depth was set at 21 cm, which allowed for complete visualization of the posterior aspect of the liver and the pleural space (ps). However, the small size of the image makes it difficult to evaluate the liver parenchyma thoroughly.

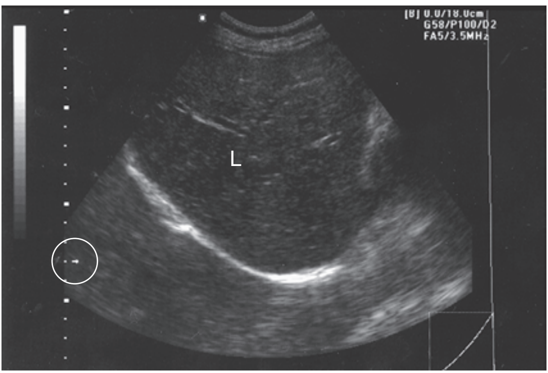


Figure 1-18A Placement of focal point settings (circled) affecting resolution. Transabdominal sagittal images of the liver (L). (A) Demonstrates the focal setting correctly placed just beyond the area being investigated. Note the normal homogeneity of the liver. The anterior, mid, and posterior aspects of the liver are visualized well.

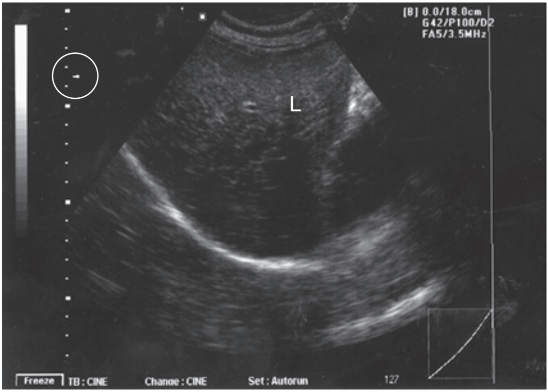


Figure 1-18B (B) The focal setting is placed in the anterior aspect of the liver. There is better resolution in the anterior aspect of the liver; however, the posterior aspect, in the far field, is poorly visualized.

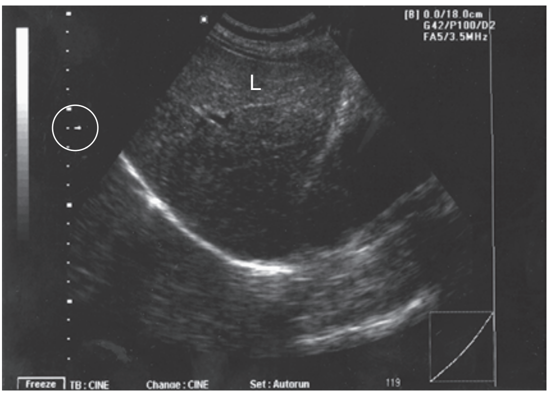


Figure 1-18C (C) Placement of the focal setting around mid depth of the liver demonstrates increased resolution in the near and midfield, but there is a loss of resolution in the posterior aspect of the liver. The decreased echogenicity makes the liver appear such that sound is being attenuated, and this may mimic liver pathology such as fatty liver disease.

Doppler

Doppler systems are used to evaluate blood flow in both large vessels (such as the aorta) and small vessels in structures and organs (such as the testicular artery). Frequently used systems include color, spectral, power, and audible Doppler.

The following are some examples of how Doppler can help in the diagnosis of pathologies:

- Detect presence of flow (such as ruling out ovarian or testicular torsion)
- Distinguish type of flow (arterial, venous, or mixed)
- Evaluate intensity of flow (such as demonstrating increased vascularity in some inflammatory conditions or malignant tumors)
- Establish direction of flow (to determine whether there is reversal of flow such as in portal hypertension)
- Calculate velocity of flow (such as evaluating for renal artery stenosis)
- Identify areas of stenosis or occlusion
- Evaluate integrity of vessels in trauma setting

The examiner must carefully adjust the Doppler flow parameters in order to obtain accurate information. Factors such as motion of the patient, obesity, and slow flow within vessels increase the difficulty in performing Doppler exams.

Ultrasound Transducers

Ultrasound transducers (Figure 1-19) convert mechanical energy to electrical energy and produce images that are displayed in a variety of formats. The most commonly used formats include sector and linear.

Image Formats

Linear Transducers

- The image is displayed as a rectangle or parallelogram (Figure 1-20).

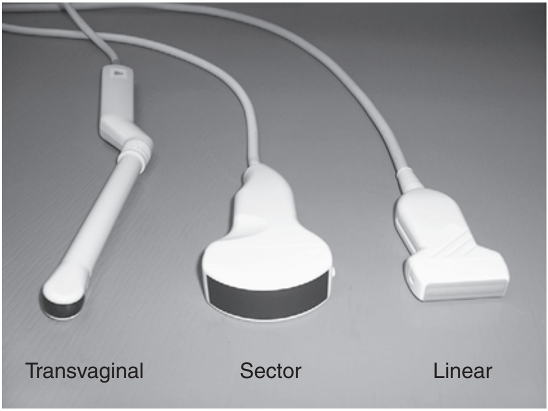


Figure 1-19 Ultrasound transducers. Samples of transvaginal, sector, and linear probes as labeled.

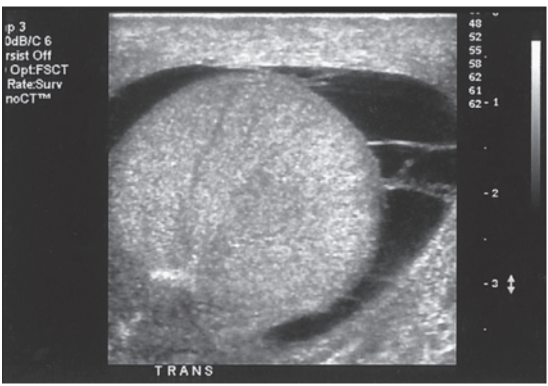


Figure 1-20 Linear transducer display. Sample of an image displayed in a rectangle format.

- The size of the field of view is equal in both the near field (area of sound penetration closest to transducer) and far field (area of sound penetration farthest from transducer).
- Linear transducers are optimal for superficial structures, such as testes.

Sector Transducers

- The image is displayed as a wedge or pie-shaped section (Figure 1-21).
- The field of view is wider in the far field than in near field.
- They are commonly used for routine abdominal and pelvic imaging.

Transducer Frequency

Linear and sector transducers have a range of frequencies generally varying from 2.0 to 12.0 MHz. Transducer selection is based on the type of exam and the patient's body habitus.

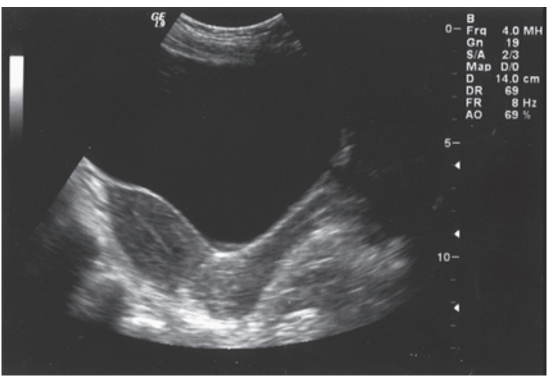


Figure 1-21 Sector transducer display. Sample of an image displayed in a wedge or pie-shaped format.

Low-Frequency Transducer

- Frequency of 2.0 MHz
- Sector format
- Results in increased sound penetration but with loss of resolution
- Suitable for abdominal and pelvic exams in obese patients

Medium-Frequency Transducer

- Frequency range 3.0 to 5.0 MHz
- Generally sector format
- Some 5.0 MHz transducers are in both linear and sector formats
- Sector suitable for imaging most adults

High-Frequency Transducer

- Frequency range of 7.0 to 14.0 MHz
- Linear or sector format
- Results in increased resolution but with reduced penetration
- Sector probes suitable for pediatric patients
- Linear probes best suited for imaging superficial structures

Image Recording

All examinations should be recorded. There are various methods of recording images, including hardcopy prints and DVD and digitally stored images on PACS (Picture Archiving and Communication System). It is very important that the patient's name, identification number, and date of the examination be included on all images.

Technical Points

Errors during scanning are commonly due to the following:

- Technical proficiency of the examiner
- Patient positioning
- Transducer selection

- Adjustment of controls (such as gain setting)
- Improper use of Doppler
- Failure to recognize artifacts and bowel loops that may mimic pathology
- Incorrect measurement of structures and organs

Summary

- Organs and structures are characterized based on the amount of echoes they generate (echogenicity) and how equally distributed these echoes are in soft tissue (homogeneity).
- Solid organs, such as the liver, are moderately echogenic and homogeneous.
- Fluid-filled organs such as the gallbladder are normally anechoic.
- Pathology is often indicated when there is a change in an organ's echogenicity or homogeneity.
- Masses are classified as anechoic, hyperechoic (echogenic), hypoechoic, or mixed in echogenicity.
- The presence of enhancement (sound transmission) is also evaluated to determine tissue characteristics (such as cystic, solid, or complex).
- Technical factors during scanning are critical to the quality of the exam and the accuracy of the diagnosis.

Chapter 2: The Liver

DUNSTAN ABRAHAM

Normal Sonographic Anatomy

- Homogeneous, echogenic texture (Figure 2-1)
- Measures approximately 15 cm in length and 10–12.5 cm anterior to posterior; measurement taken at mid clavicular in longitudinal section
- Divisions—right, left, and caudate lobes (Figure 2-2)
- Main lobar fissure
  - Echogenic line extending to gallbladder fossa (Figure 2-3)
  - Separates right and the left lobes
- Falciform ligament (contains ligamentum teres)
  - Round, hyperechoic area in left lobe (Figure 2-3)
  - Divides left lobe into medial and lateral segments
- Fissure for ligamentum venosum
  - Echogenic line anterior to caudate lobe (Figure 2-4)
  - Separates caudate from left lobe

Hepatic Vessels

- Portal veins
  - Main portal vein enters liver at hilum (Figure 2-5).
  - Divides into right and left branches
  - Right branch divides into anterior and posterior branches.
  - Left branch divides into medial and lateral branches (Figure 2-6).
  - Walls are thick and echogenic.
- Hepatic veins
  - Right, middle, and left branches drain into inferior vena cava (Figure 2-7).
  - Walls are thin compared with thick-walled portal vein (Figure 2-8).

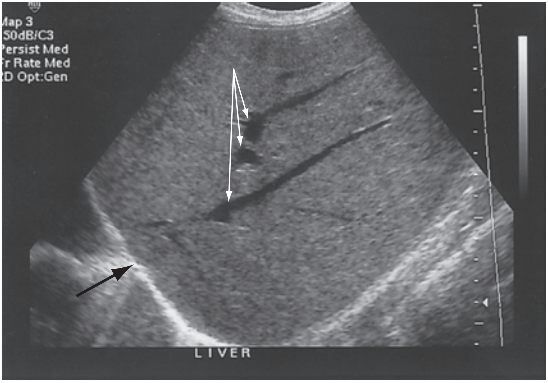


Figure 2-1 Normal Liver. A longitudinal sonogram demonstrates a homogeneous liver with midlevel echoes. Anechoic structures (white arrows) represent normal vessels. The diaphragm (black arrow) is seen superiorly.

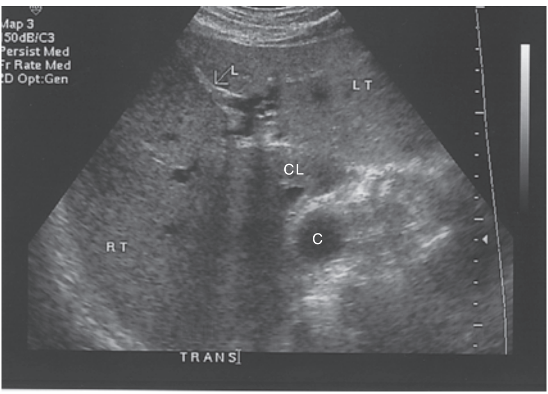


Figure 2-2 Lobes of the liver. Transverse view shows right (RT), left (LT), and caudate (CL) lobes of the liver. The inferior vena cava (C) is seen posterior to the caudate lobe (CL). L—main lobar fissure.

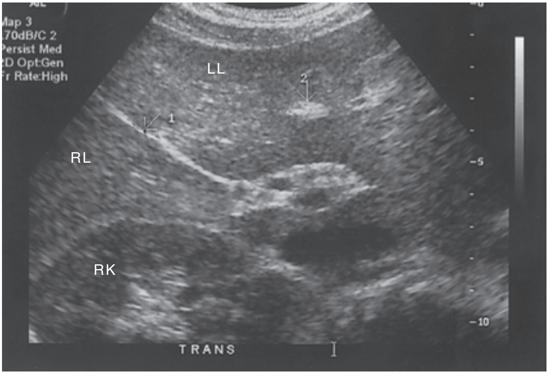


Figure 2-3 Main lobar fissure and falciform ligament. A transverse sonogram shows main lobar fissure (1) separating the right lobe (RL) from the left lobe (LL). The falciform ligament (2) is seen within the left lobe. The right kidney (RK) is seen posterior to the right lobe.

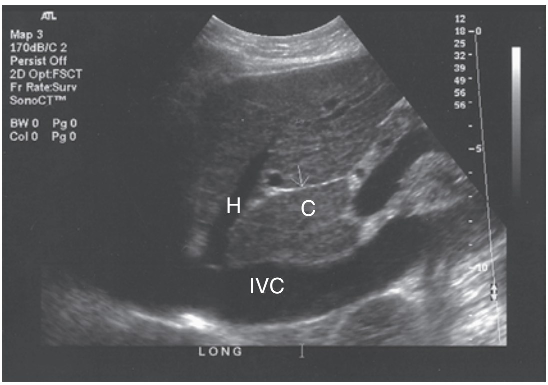


Figure 2-4 Fissure for ligamentum venosum. A longitudinal scan shows fissure for ligamentum venosum (arrow) anterior to the caudate lobe (C). The left hepatic vein (H) is seen joining the inferior vena cava (ivc).

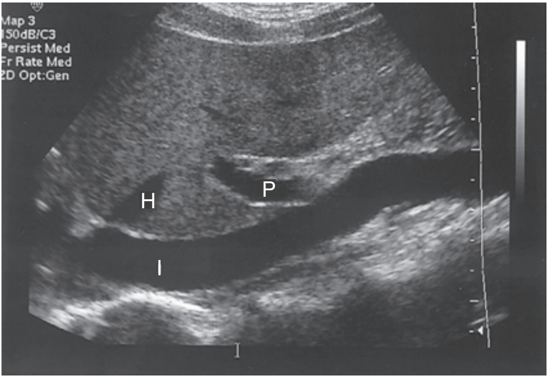


Figure 2-5 Main portal vein. A longitudinal sonogram shows main portal vein (P) as it enters hilum of the liver. The inferior vena cava (I) and hepatic vein (H) are also demonstrated.

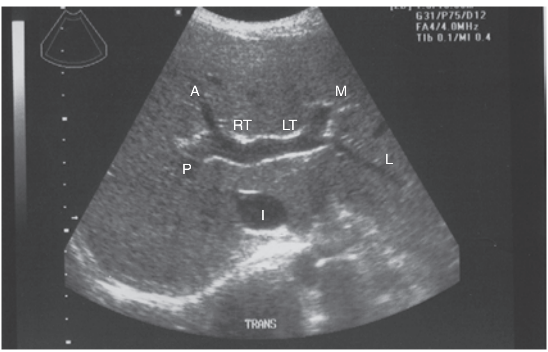


Figure 2-6 Branches of the portal vein. A transverse image showing the right branch of the portal vein (RT) dividing into anterior (A) and posterior (P) segments. The left branch (LT) divides into medial (M) and lateral (L) segments. The inferior vena cava (I) is seen posteriorly. Note the echogenic borders of the portal vein.

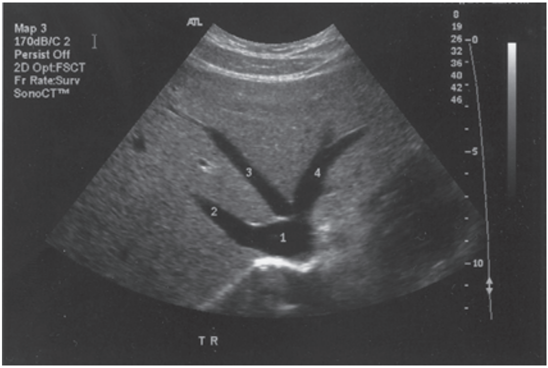


Figure 2-7 Hepatic veins. A transverse sonogram showing right (2), middle (3), and left (4) hepatic veins draining into the inferior vena cava (1).

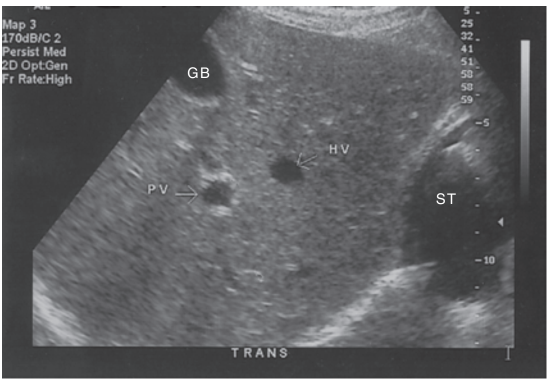


Figure 2-8 Portal and hepatic veins. A transverse sonogram showing a section of portal vein (PV) with its hyperechoic borders adjacent to a section of hepatic vein (HV), which has thin border (not hyperechoic). The gallbladder (GB) and fluid-filled stomach (ST) are also identified.

- Hepatic artery
  - Generally seen between the common bile duct and the portal vein as small, rounded, anechoic structure
  - Linear and anechoic when demonstrated in oblique long axis view (Figure 2-9)
- Intrahepatic bile ducts
  - Are anechoic and seen anterior to portal vein
  - Measure less than 2 mm in anterior to posterior dimensions
- Diaphragm seen as curvilinear hyperechoic structure abutting liver superiorly
- Reidel's lobe
  - Downward projection of right lobe (Figure 2-10)
  - May give false appearance of hepatomegaly

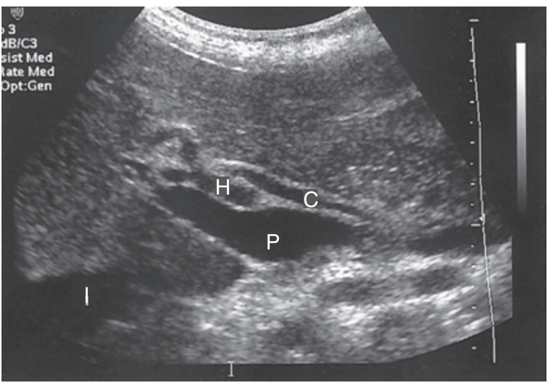


Figure 2-9 Hepatic artery. A longitudinal oblique view demonstrates the hepatic artery (H) between the main portal vein (P) and common bile duct (C) as it enters the liver. I—inferior vena cava.

Figure 2-10 Reidel's lobe. A longitudinal image shows a Reidel's lobe (RL) projecting from the right lobe of the liver. The right kidney (RK) is seen posteriorly.

Liver Pathology

Diffuse Diseases

Hepatomegaly

- Liver measures more than 15 cm in length (Figure 2-11)
- Commonly seen with infiltrative diseases and masses in the liver

Fatty Liver

- Mild (early stage)
  - Minimal increase in liver echogenicity
  - Intrahepatic vessels and diaphragm well visualized (Figure 2-12A)
- Moderate (mid stage)
  - Moderate increase in liver echogenicity
  - Intrahepatic vessels and diaphragm suboptimally visualized

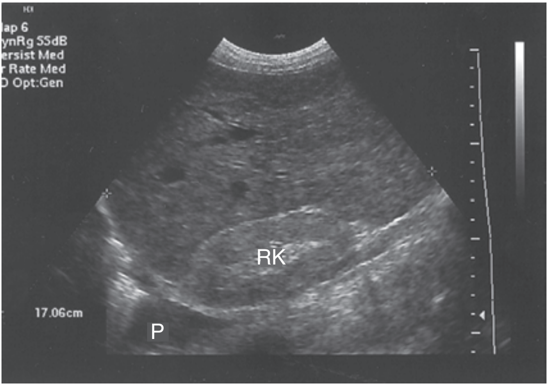


Figure 2-11 Hepatomegaly. Liver measurement in a longitudinal section shows enlargement of the organ (RK—right kidney, P—pleural effusion).

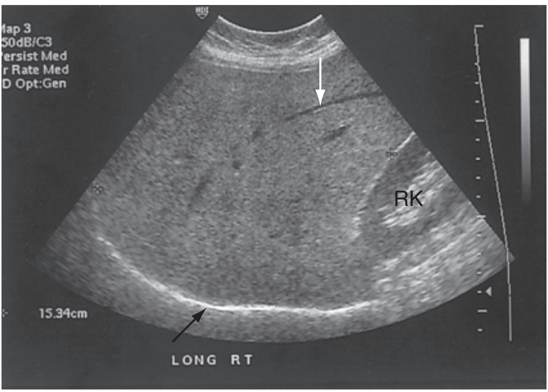


Figure 2-12A Mild fatty infiltration of the liver. A longitudinal image showing generalized increased echogenicity of the liver. Note that the diaphragm (black arrow) and section of an intrahepatic vessel (white arrow) are well visualized. Right kidney (RK) is posterior to the liver.

- Severe (late stage)
  - Significant increase in liver echogenicity
  - Poor visualization of posterior aspect of liver
  - Poor or nonvisualization of intrahepatic vessels and diaphragm (Figure 2-12B)
- Focal fat infiltration
  - Hyperechoic area within an otherwise normal liver; commonly seen in right lobe and may resolve over time (Figure 2-13)
- Focal fat sparing
  - Area of normal liver within fatty liver; commonly seen anterior to portal vein and gallbladder (Figure 2-14)
- Focal fat infiltration and sparing may mimic liver tumor

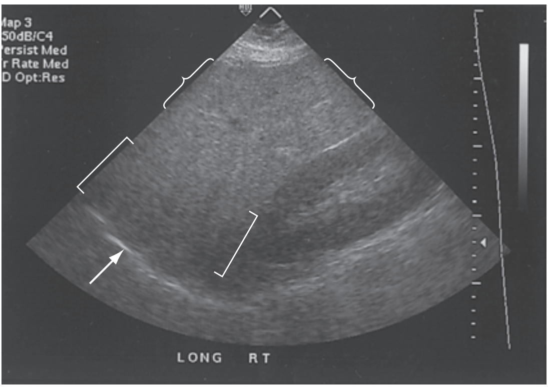


Figure 2-12B Severe fatty infiltration of the liver. A longitudinal image showing increased echogenicity of the liver in the anterior segment { }. The posterior segment [ ] is hypoechoic because of poor penetration of the beam. The diaphragm (arrow) is poorly demonstrated and the intrahepatic vessels are not seen.

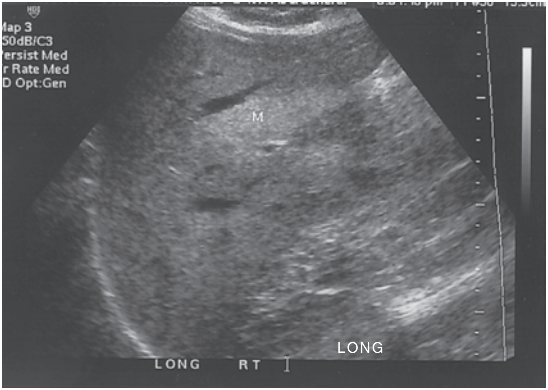


Figure 2-13 **Focal fatty infiltration.** A longitudinal image showing hyperechoic area (M) consistent with focal fatty infiltration.

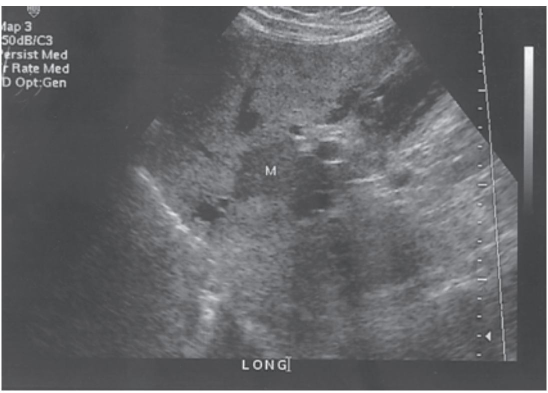


Figure 2-14 **Focal fatty sparing.** The longitudinal image demonstrates normal liver (M) surrounded by liver with increased echogenicity caused by fatty infiltration.

Cirrhosis

- Early stage
  - Liver echogenicity increased
- Late stage
  - Irregular surface (nodules), enlarged caudate lobe, and small right lobe (Figure 2-15A,B)
- Associated findings may include dilated portal vein, portal vein flow away from liver (hepatofugal), recanalized umbilical vein, splenomegaly, and ascites.
- Ascites seen as anechoic area or areas around abdominal organs and in flanks and pelvis (see Chapter 12)

Cystic Masses

Epithelial Cyst

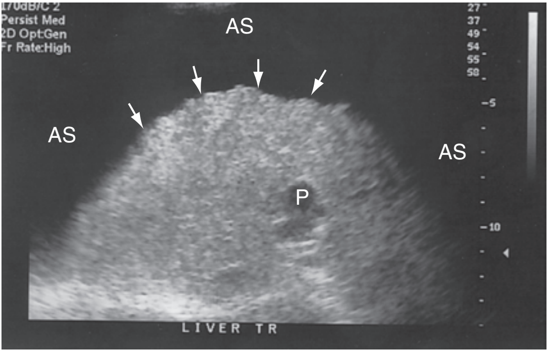
- Single or multiple, anechoic, well-defined cystic mass(es) with good posterior enhancement (Figure 2-16)
- Cyst may become complex with internal echoes caused by hemorrhage or infection (Figure 2-17).
- Complex cyst may mimic tumor.

Polycystic Liver Disease

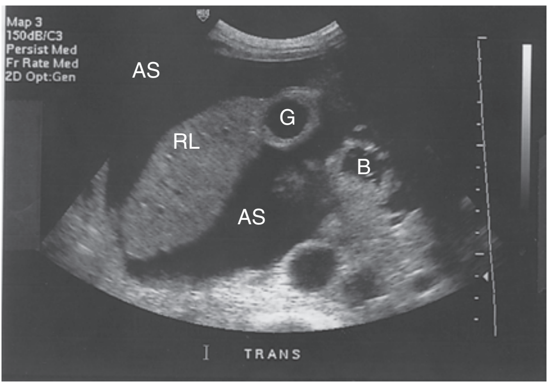
- Multiple anechoic masses with posterior enhancement (Figure 2-18)
- May have low level echoes (debris)
- May have echogenic wall calcification
- Associated with polycystic kidney disease (see Chapter 6)

Inflammatory Diseases (Abscesses)

- Common types include echinococcal, pyogenic, and amebic.
- Abscesses may be intrahepatic, subhepatic, and subphrenic (subdiaphragmatic).
- Variable sonographic appearances as described later here



(A)



(B)

Figure 2-15A & B Late stage cirrhosis. Transverse views of the liver demonstrate surface nodularity in (A) (white arrows) and a small right lobe (RL) in image (B). Ascites (AS) is seen surrounding the liver. P—portal vein, G—gallbladder, B—bowel.

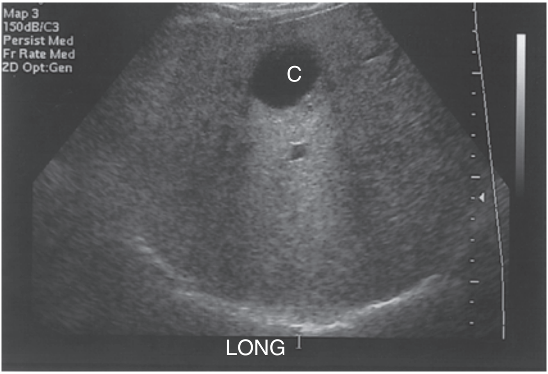


Figure 2-16 Epithelial cyst. Longitudinal image shows a simple hepatic cyst (C), which is anechoic with smooth borders, and acoustic enhancement posteriorly.

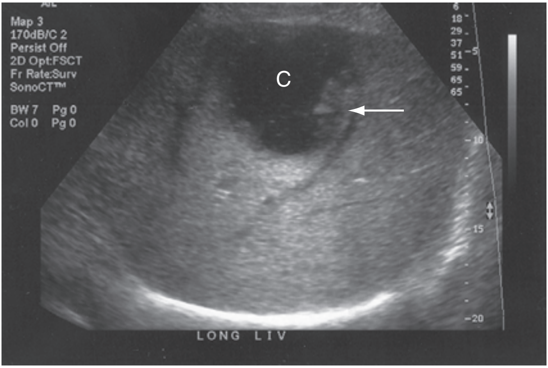


Figure 2-17 Complex hepatic cyst. Longitudinal view show hepatic cyst (C) with medium-level echoes (white arrow).

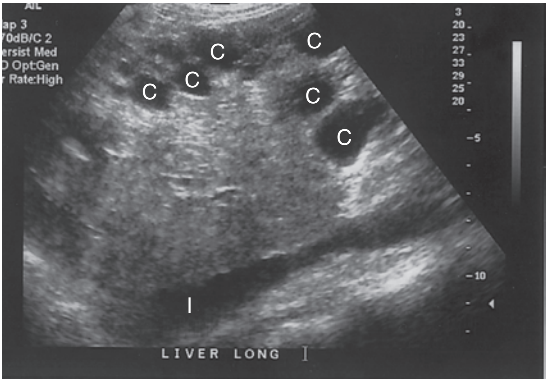


Figure 2-18 Polycystic liver disease. Longitudinal sonogram showing multiple liver cysts (C) in a patient with advanced polycystic kidney disease. I—inferior vena cava.

Echinococcal Cysts

- Varies from simple cysts (completely anechoic) to complex mass (cyst with internal echoes)
- Posterior enhancement
- Echogenic thin linear septations and wall calcifications may be seen
- Large cyst (mother cyst) with smaller cysts within (daughter cysts) is specific for echinococcosis (Figure 2-19).

Pyogenic Abscess

- Round or ovoid mass
- Irregular walls
- Anechoic to hyperechoic
- Enhancement in most cases
- Echogenic area with shadowing represents air from gas-producing organisms (Figure 2-20)

Amebic Abscess

- More common in right lobe
- Round or oval shape mass

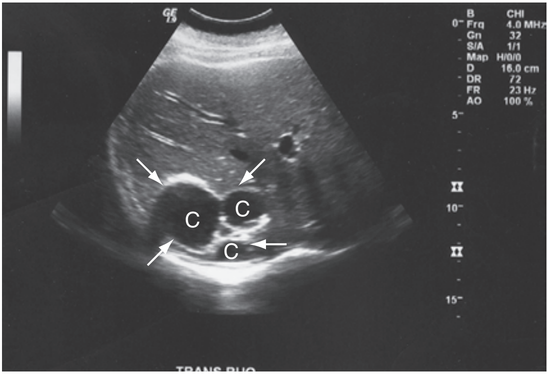


Figure 2-19 Echinococcal cyst. The transverse sonogram of the liver demonstrates a mother cyst (between arrows) containing several daughter cysts (C).

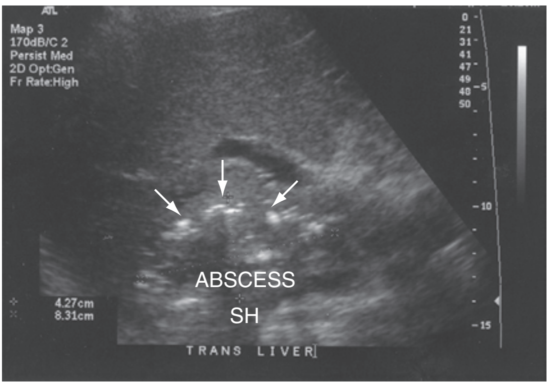


Figure 2-20 Pyogenic abscess. Transverse image of the right lobe of liver showing a pyogenic abscess. Note the presence of multiple echogenic foci (arrows) with shadowing (SH) posteriorly. These represent gas bubbles within the abscess.

- Low-level internal echoes (Figure 2-21A,B)
- Distal acoustic enhancement

Benign Liver Tumors

Cavernous Hemangioma

- Commonly seen in posterior aspect right lobe
- Round, hyperechoic solid mass (Figure 2-22)
- Well-defined borders
- Normally less than 3 cm in size but may be larger
- Can mimic liver tumor

Focal Nodular Hyperplasia

- Commonly isoechoic to liver texture but may be hyperechoic to hypoechoic (Figure 2-23)
- May have a central fibrous scar that may be hypoechoic or hyperechoic and linear
- Increased vascularity within central scar
- May mimic hepatoma or adenoma (see later here)

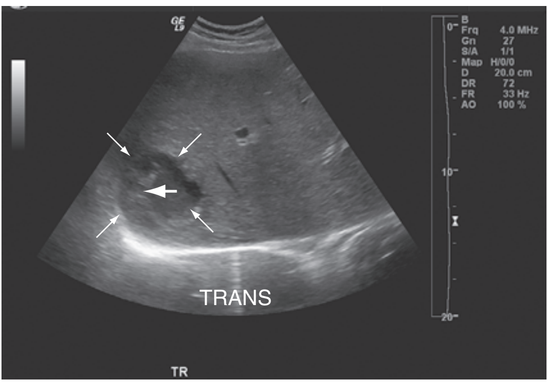


Figure 2-21A Amebic abscess. (A) A transverse sonogram showing an amebic abscess (between white arrows) in the right lobe of liver. Note the presence of diffuse low-level echoes and a thick septation (small white arrow).

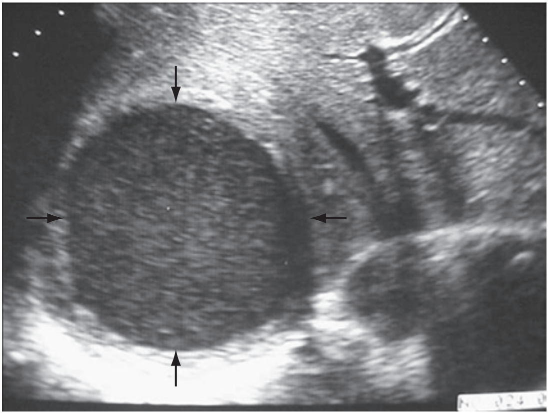


Figure 2-21B (B) The transverse view shows a large, well-defined cystic mass with low-level echoes and moderate posterior enhancement (between arrows).

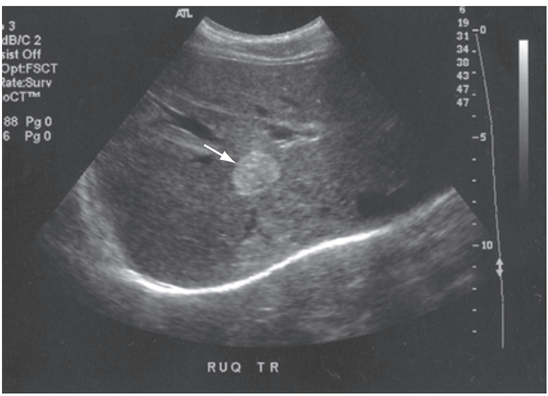


Figure 2-22 **Cavernous hemangioma.** The transverse view demonstrates a small, rounded hyperechoic mass (arrow) consistent with a hemangioma.

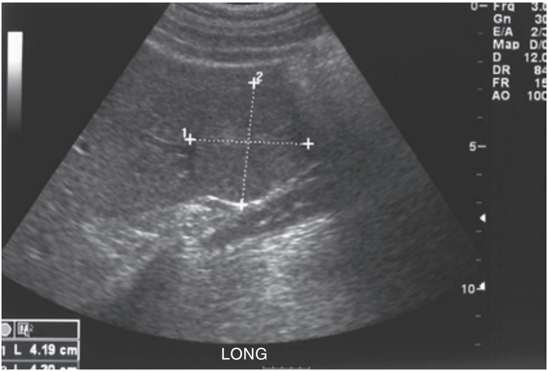


Figure 2-23 Focal nodular hyperplasia. Longitudinal section of liver with a rounded mass (between calipers), which is isoechoic to the adjacent liver texture. This represents focal nodular hyperplasia.

Liver Cell Adenoma

- Hypoechoic, hyperechoic, isoechoic, or complex mass
- Fluid component and intraperitoneal blood seen with hemorrhage
- May mimic focal nodular hyperplasia

Lipoma and Angiomyolipoma

- Well-defined echogenic masses (Figure 2-24)
- May mimic hemangiomas, liver metastasis, or focal fat infiltration

Malignant Hepatic Neoplasms

Hepatoma (Hepatocellular Carcinoma) and Metastasis

- Hepatomas and metastasis may have a similar appearance.
- Single or multiple masses
- Hypoechoic, isoechoic, or hyperechoic to liver texture (Figure 2-25)

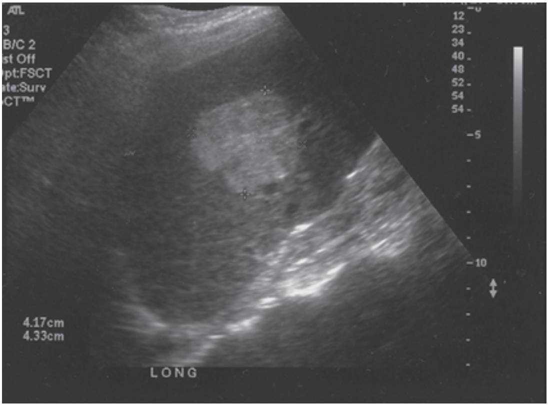


Figure 2-24 Lipoma. Longitudinal image shows lipoma as an echogenic liver mass (between calipers).

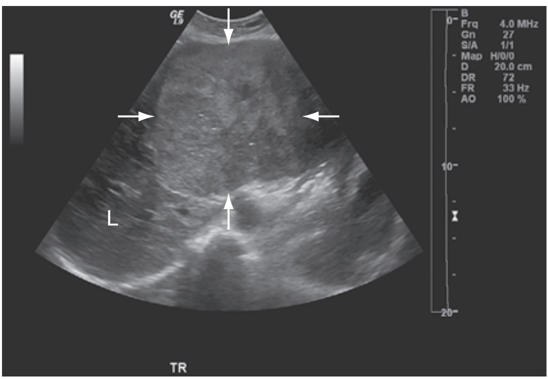
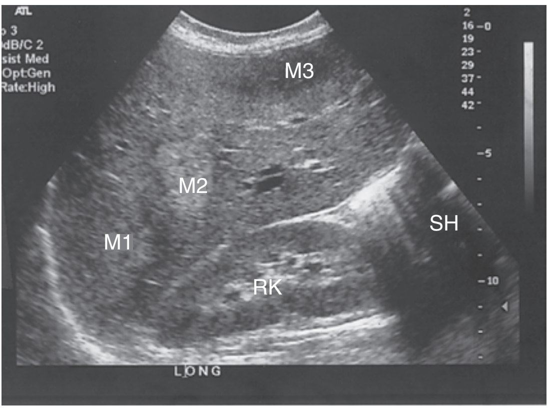
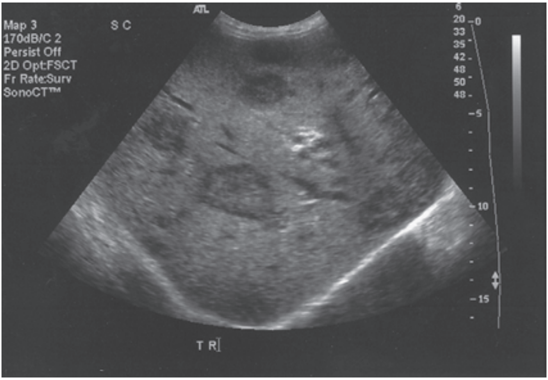


Figure 2-25 Hepatoma. Transverse view of the liver showing a large hepatoma, which presents as a discrete mass with well-defined borders (between arrows). The mass is slightly more echogenic than the adjacent areas of normal liver texture (L).

- Metastatic lesions commonly have the following features:
  - Multiple masses (Figure 2-26A)
  - Hypoechoic mass with echogenic center (bull's-eye appearance) (Figure 2-26 B)
  - Echogenic calcification(s)
  - Diffusely inhomogeneous liver parenchyma without discrete mass(es) (Figure 2-26C)
- Low-level echoes in portal vein, hepatic vein, IVC, and bile ducts may represent tumor (Figure 2-27).
- Benign tumors (e.g., adenomas and focal nodular hyperplasias) can mimic hepatomas and metastasis



(A)



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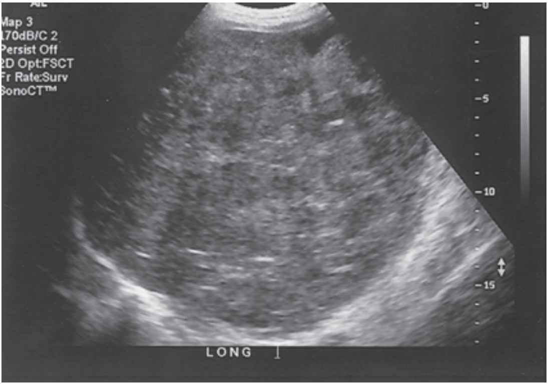


(C)

Figure 2-26A–C Liver Metastasis. Longitudinal (A and C) and transverse (B) views demonstrating various sonographic patterns of metastasis. In (A), liver masses are of varying echogenicities when compared with the adjacent liver texture. Mass (M1) is isoechoic, mass (M2) hyperechoic, and mass (M3) is hypoechoic. In (B), a bull's-eye appearance is seen as hypoechoic masses with an echogenic center. In (C), the liver is diffusely inhomogeneous without a discrete mass or masses.

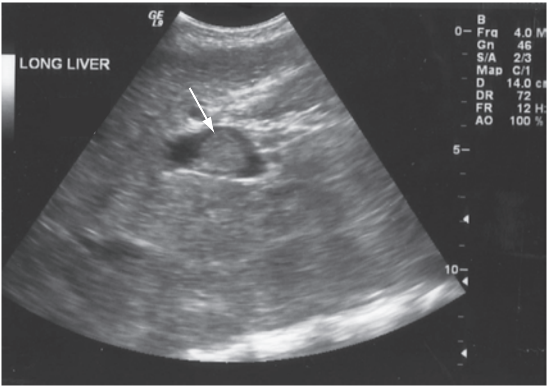


Figure 2-27 Tumor/thrombus in portal vein. The echogenic mass (arrow) seen in the portal vein represents tumor. Note the inhomogeneity of liver texture consistent with metastatic disease.

Chapter 3: The Gallbladder and Bile Ducts

DUNSTAN ABRAHAM

Normal Sonographic Anatomy

- Echogenic main lobar fissure leads to gallbladder fossa (Figure 3-1).
- Anechoic gallbladder has three segments—neck, body, and fundus (Figure 3-2).
- Common variants:
  - Phrygian cap—fold at fundus (Figure 3-3)
  - Hartman's pouch—fold at neck (Figure 3-3)
  - Junctional fold—fold between body and neck
  - Septation—seen as a linear hyperechoic structure within gallbladder
- Folds in gallbladder can mimic pathology (discussed later).
- Normal gallbladder wall thickness less than 3 mm; best measured on a transverse view (Figure 3-4)
- Size and shape variable, but should not exceed 5 cm in anterior to posterior dimension

Gallbladder Pathology

Cholelithiasis (Gallstones)

- Criteria for diagnosis
  - Single or multiple echo(s) within gallbladder with posterior acoustic shadowing (Figure 3-5A,B)
  - Stones mobile and gravity dependent (Figure 3-6)
- Contracted gallbladder filled with stones—WES sign used to make diagnosis; W (wall) E (echo) S (shadow) (Figure 3-7A,B)
- The following can mimic gallstones
  - Valves of Heisters and folds in gallbladder
  - Air-filled loops of bowel adjacent to gallbladder (Figure 3-8A,B)
  - Surgical clips postcholecystectomy (Figure 3-9)

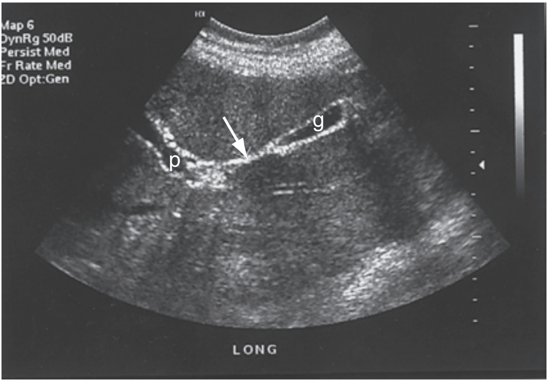


Figure 3-1 Main lobar fissure. Longitudinal sonogram demonstrates the hyperechoic main lobar fissure (arrow) extending from portal vein (p) to the gallbladder (g).

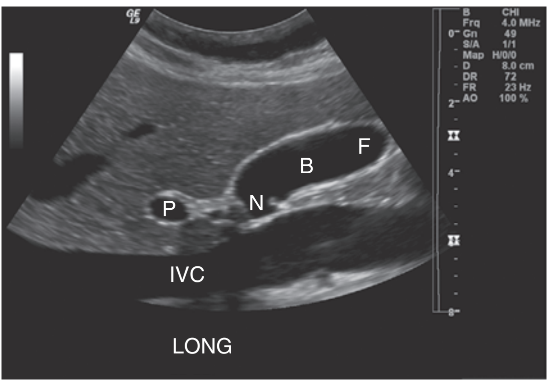


Figure 3-2 Normal gallbladder. A longitudinal image demonstrates neck (N), body (B), and fundus (F) of gallbladder. P—portal vein, IVC—inferior vena cava.

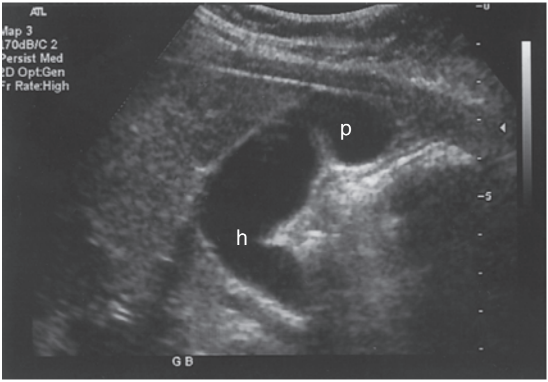


Figure 3-3 Harman's pouch and Phrygian cap. A longitudinal view of gallbladder folds demonstrates Hartman's pouch (h) and Phrygian cap (p).

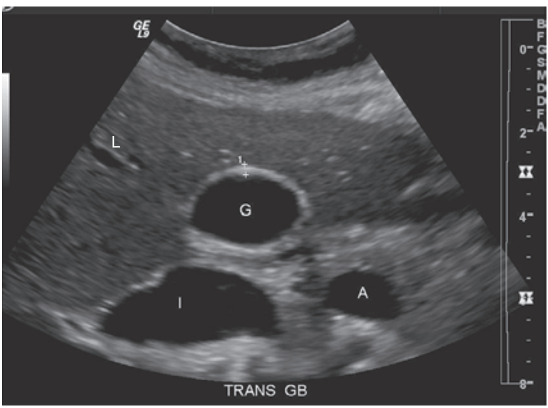


Figure 3-4 Wall thickness measurement of gallbladder. Transverse view of gallbladder (GB) with measurement of wall thickness (between calipers). I—inferior vena cava, A—aorta, and L—liver.

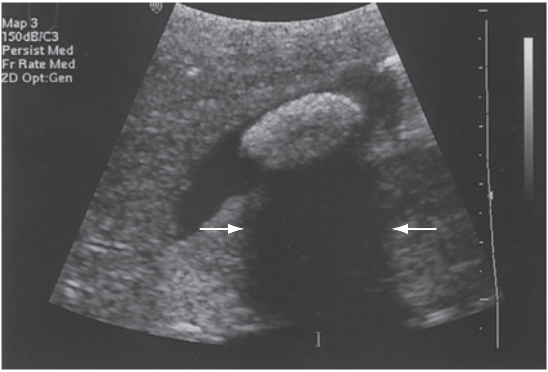


Figure 3-5A **Gallstones.** A single large gallstone with shadowing (between arrows) is seen in (A).

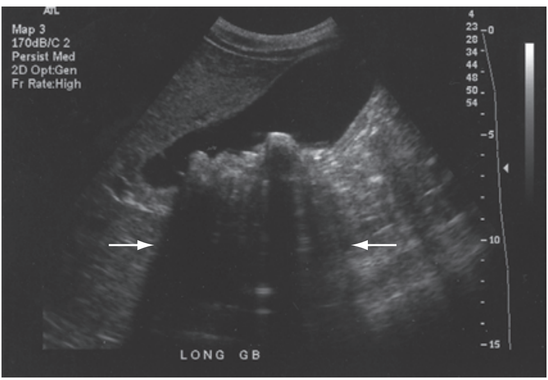


Figure 3-5B In (B), multiple small gallstones are seen that cast an acoustic shadow (between arrows).

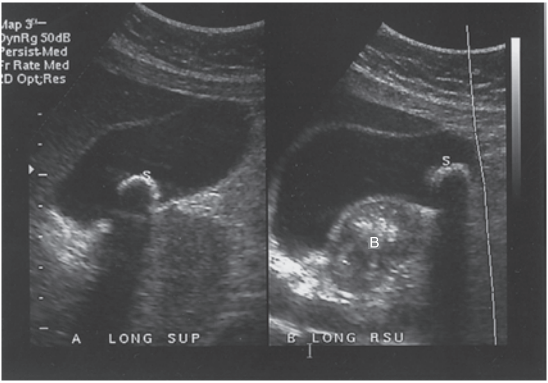


Figure 3-6 Mobility of gallstone. Longitudinal views of gallbladder with patient in supine position A and left lateral decubitus B. Note the movement of stone(s) to a more fundal position when patient's position is changed. Bowel (B) is seen posterior to gallbladder.

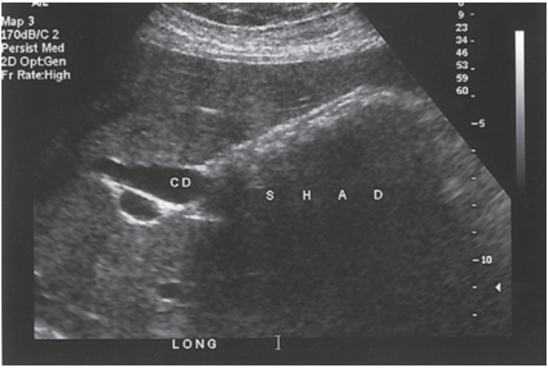


Figure 3-7A Wall-echo-shadow complex. Longitudinal A and transverse B images of the gallbladder filled with stones. CD—common bile duct, SHAD—shadowing.

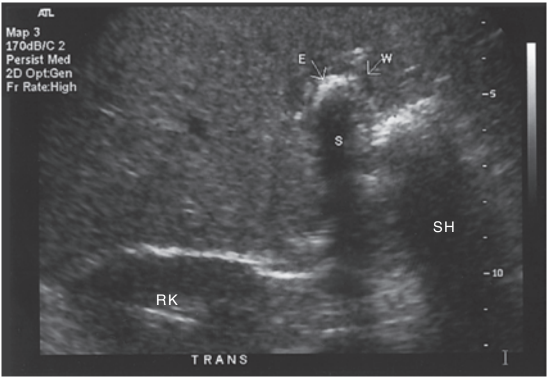


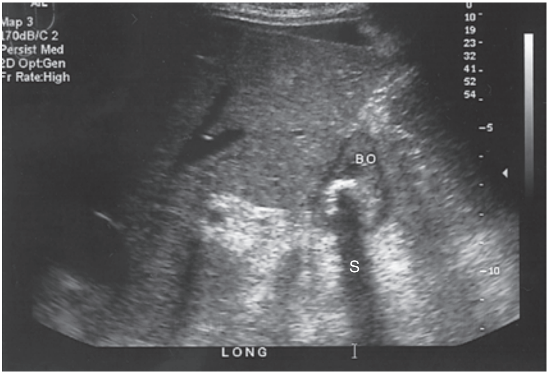
Figure 3-7B The WES sign is seen to better advantage in image B (W—wall of gallbladder, E—echo from gallstone, and S—shadowing). RK—right kidney and SH—shadowing from adjacent bowel loops.

Sludge

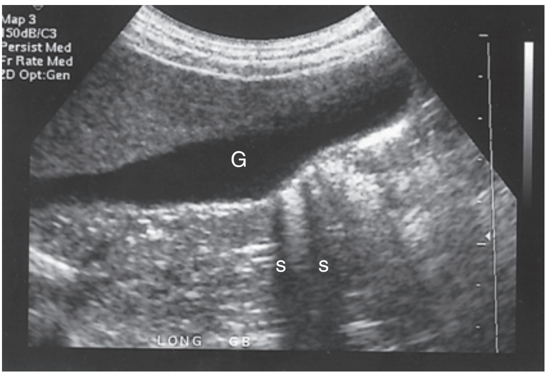
- Low-level echoes within gallbladder without shadowing (Figure 3-10)
- Mobility and layering within gallbladder
- May fill gallbladder and become isoechoic to liver
- May aggregate to mimic tumor (sludge ball or tumefactive sludge) (Figure 3-11A,B)
- Sludge balls lack internal vascularity and may demonstrate gravity-dependent motion (depending on size).

Polyp

- Single or multiple nonshadowing echogenic mass(es) within gallbladder (Figure 3-12)
- Mass(es) fixed to gallbladder wall (nonmobile)
- Folds in gallbladder may mimic polyps especially on a transverse view.



(A)



(B)

Figure 3-8A & B Bowel mimicking gallstones. In (A), a bowel loop (BO) mimics a contracted gallbladder with a stone casting an acoustic shadow (S). In (B), normal gallbladder (G) has areas of shadowing (S) on its posterior surface from adjacent bowel loops. In both cases, changing the patient's position and observing for peristalsis can distinguish between shadowing bowel loops and gallstones.

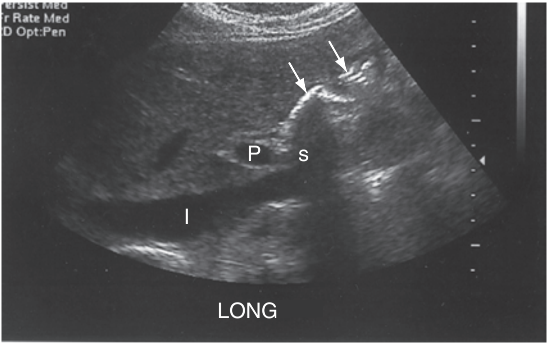


Figure 3-9 Surgical clips mimicking gallstones. Post-cholecystectomy patient with surgical clips (arrows) in gallbladder fossa casting an acoustic shadow (S). This appearance may mimic gallstones in a contracted gallbladder. I—inferior vena cava and P—portal vein.

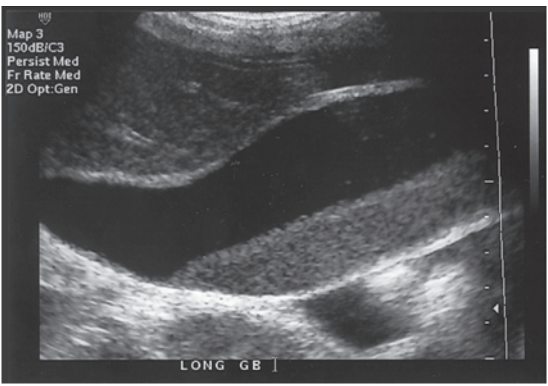
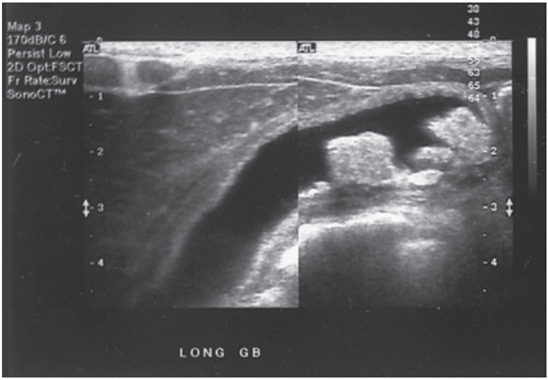
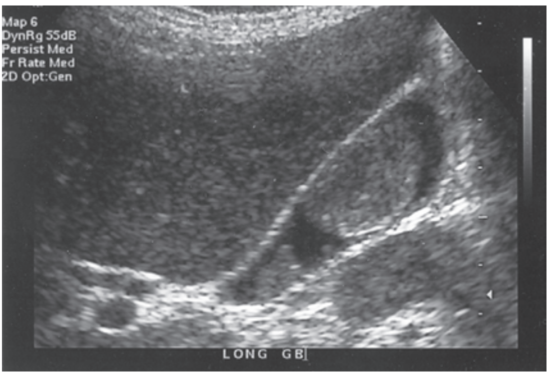


Figure 3-10 Sludge in gallbladder. Sagittal image shows distended gallbladder with sludge (low level echoes) layering on posterior surface.



(A)



(B)

Figure 3-11A & B Tumefactive bile. Sagittal images show gallbladder filled with echogenic masses (sludge balls). Although this appearance can mimic a tumor, sludge balls may demonstrate mobility unlike neoplasms, which are adherent to the walls.

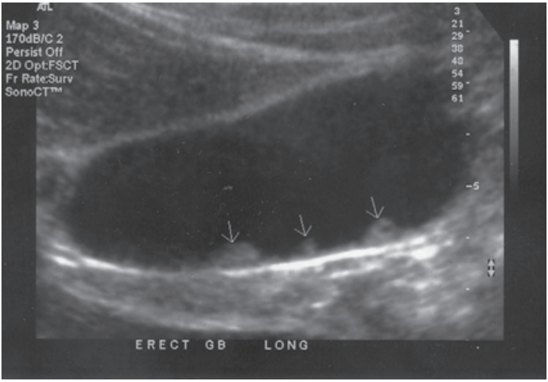


Figure 3-12 **Gallbladder polyps.** Longitudinal view of patient in erect position shows multiple echogenic polyps that are nonmobile.

Adenomyomatosis

- Most common appearance is echogenic foci within gallbladder with comet-tail artifact (Figure 3-13)
- Above appearance may mimic polyps.
- Adenomyomatosis can also be seen as focal area mimicking a mass in fundus or body of gallbladder.
- Focal adenomyomatosis in body of gallbladder may cause narrowing at midportion (hourglass gallbladder).
- Gallbladder wall may be thickened.

Cholecystitis

Acute Calculous Cholecystitis

- Gallstones present
- Diffuse wall thickening (greater than 3 mm) and pericholecystic fluid (Figure 3-14)

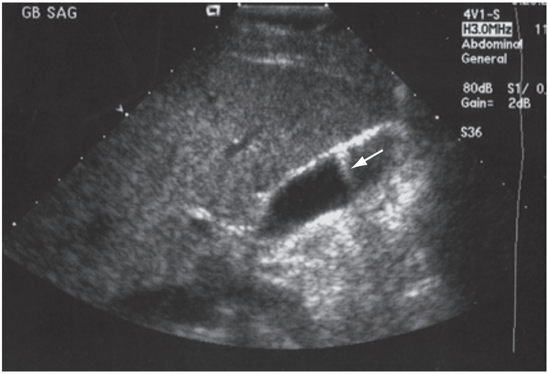


Figure 3-13 Adenomyomatosis. Longitudinal image of the gallbladder demonstrates echogenic foci with ring-down artifact (arrow). This appearance is consistent with adenomyomatosis.

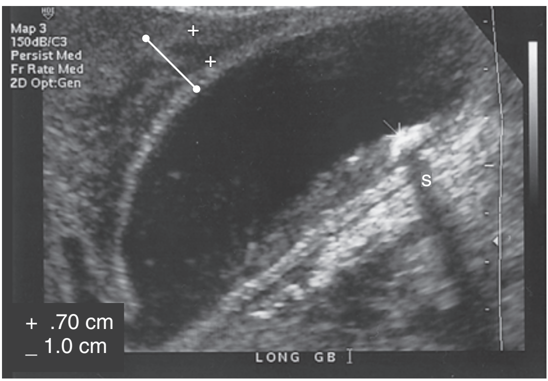


Figure 3-14 Acute calculus cholecystitis. Longitudinal image of the gallbladder demonstrates gallstone (arrow) with posterior shadowing(s). Thickened gallbladder wall is indicated by the solid line. An edematous portion of thickened gallbladder wall is demonstrated between the plus signs.

- Hydrops—gallbladder dilation greater than 4 cm in anterior to posterior measurement; has rounded shape (Figure 3-15)
- Focally tender gallbladder when being examined (sonographic Murphy's sign)
- Increased vascularity around gallbladder seen occasionally (Figure 3-16)
- Gallbladder wall thickening may also be seen in the following conditions: nonfasting state (Figure 3-17), ascites (Figure 3-18), AIDS, hepatic dysfunction, and chronic heart failure.

Complications of Acute Cholecystitis

- Emphysematous cholecystitis
  - Appearance dependent on amount of gas within gallbladder
  - Echogenic line with dirty posterior shadow or ringdown artifact within gallbladder (when small amount of gas present)

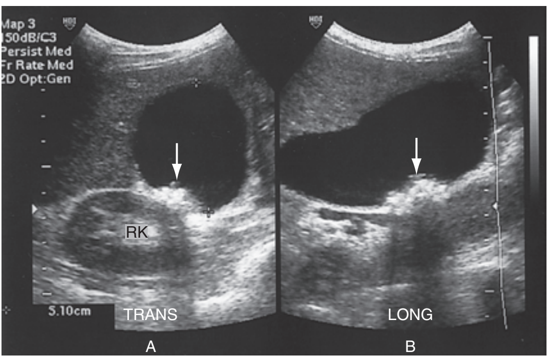


Figure 3-15 Gallbladder hydrops. Transverse (A) and longitudinal (B) images of a dilated gallbladder representing hydrops. It measures 5.1 cm in anterior to posterior diameter. Gallstones with shadowing are also noted within the gallbladder (arrow). RK—right kidney.

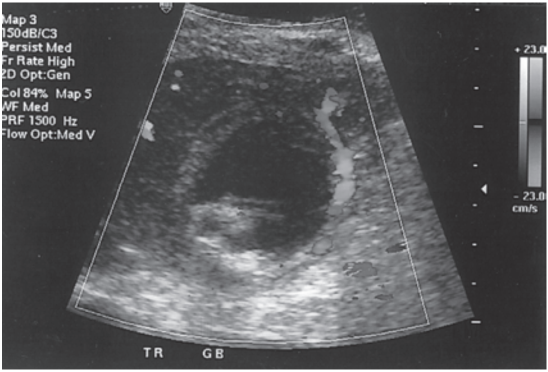


Figure 3-16 Acute cholecystitis with increased vascularity. Transverse view of the gallbladder with increased vascularity around lateral wall of the gallbladder on color Doppler (see color inserts).

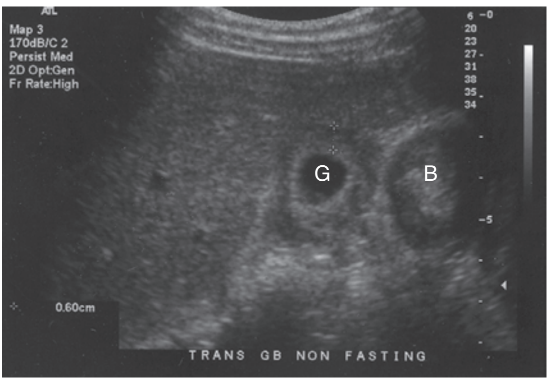


Figure 3-17 Gallbladder wall thickening in a nonfasting patient. Transverse image showing gallbladder (G) with thickened walls (between markers) in a patient who is nonfasting. B—bowel.

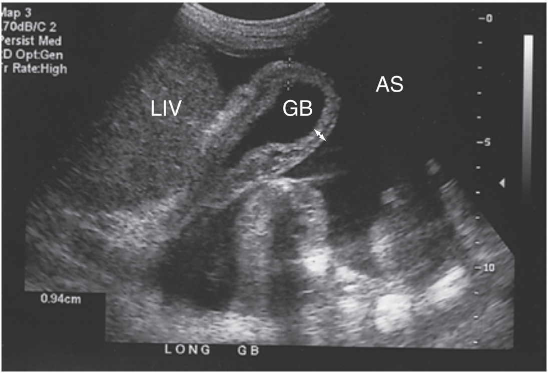


Figure 3-18 Gallbladder wall thickening with ascites. Sagittal view of gallbladder (GB) with symmetrically thickened echogenic wall (between arrowheads). Ascites (AS) is seen around gallbladder and liver (LIV).

    - Echogenic line in gallbladder fossa with dirty shadowing (when large amount of gas present)
- Gangrenous cholecystitis
    - Echogenic tissues within gallbladder (Figure 3-19)
    - Septations within gallbladder
- Perforated cholecystitis
    - Complex echogenic fluid around gallbladder (Figure 3-20)
    - Gallbladder may be small or nonvisible

Chronic Cholecystitis

- Seen as gallstones and thickened gallbladder wall
- Gallbladder may be contracted with WES sign.

Acalculous Cholecystitis

- Difficult to diagnose with ultrasound
- Wall thickening present
- Sonographic Murphy's sign may be present.

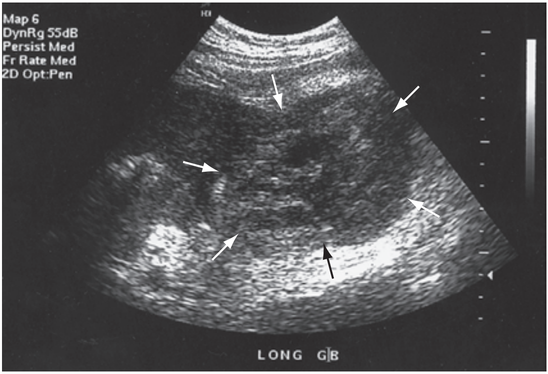


Figure 3-19 Gangrenous cholecystitis. Echogenic tissue almost entirely filling the dilated gallbladder (between arrows) in patient with acute cholecystitis. This represents sloughed membranes and blood.

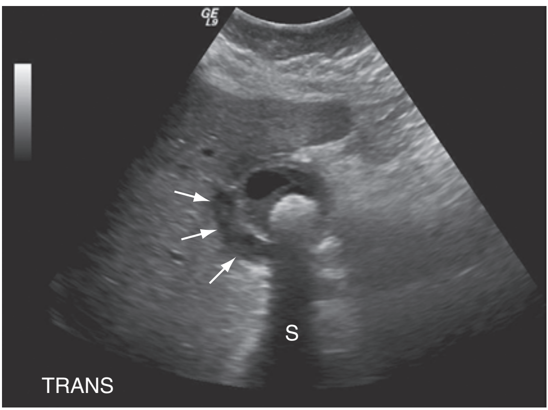


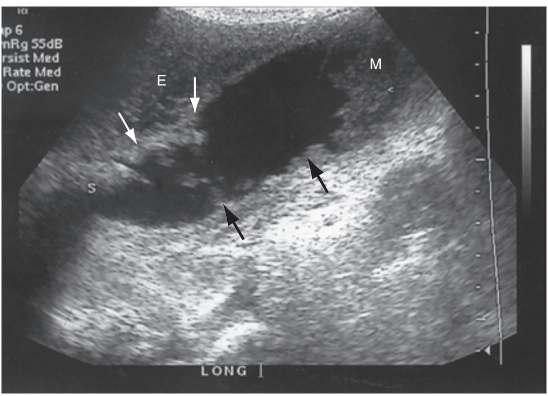
Figure 3-20 Perforated cholecystitis. A transverse sonogram in a patient with acute cholecystitis demonstrates free fluid (arrows) consistent with perforation. A large gallstone with acoustic shadowing (S) is also present.

Carcinoma

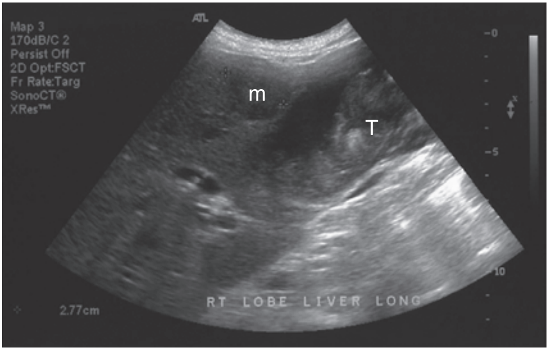
- Focal or diffuse wall thickening (Figure 3-21A)
- Echogenic mass within gallbladder (Figure 3-21B,C)
- Echogenic mass in gallbladder fossa (gallbladder not visualized)
- Gallstones seen in most cases
- Associated findings
  - Porcelain gallbladder (see later in this section)
  - Liver metastasis and lymphadenopathy

Porcelain Gallbladder

- Hyperechoic wall caused by calcification (Figure 3-22)
- Above more commonly seen on the anterior wall; posterior wall obscured by shadowing
- Associated with gallbladder malignancy
- Can mimic gallbladder filled with stones



(A)



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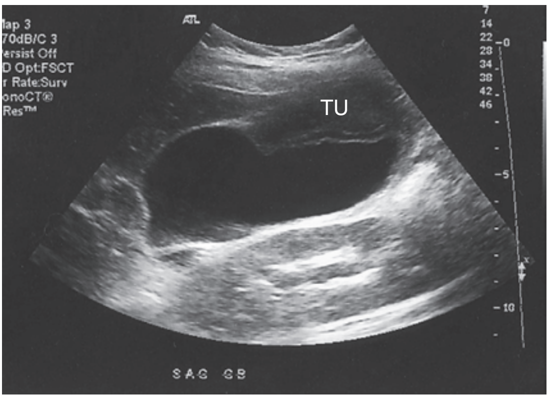


(C)

Figure 3-21A–C Gallbladder carcinoma. In (A), the gallbladder has asymmetrical wall thickening (arrows) and a solid mass (M) in the fundus. Gallstones with shadowing (s) and wall edema (E) are also noted. In (B), the tumor (T) is almost filling the gallbladder lumen, and liver metastasis (m) is also seen. In (C), the large tumor mass (TU) occupies the anterior aspect of the gallbladder.

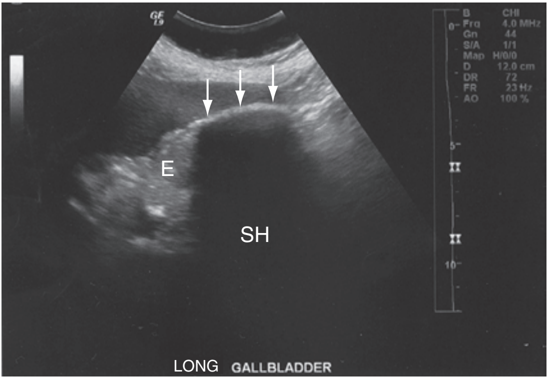


Figure 3-22 Porcelain gallbladder. Longitudinal image of gallbladder with calcification of the anterior wall (arrows) and shadowing (SH). This obscures the visualization of the posterior wall of the gallbladder. Echoes in the gallbladder (E) are partially visualized.

The Bile Ducts

Normal Sonographic Anatomy

- Tubular, anechoic structures
- Common bile duct (CBD) seen anterior to main portal vein (Figure 3-23)
- Lumen of the CBD normally measures up to 6 mm and up to 10 mm in postcholecystectomy patients.
- Hepatic artery seen between CBD and portal vein
- Intrahepatic bile ducts seen anterior to branching portal veins and measure less than 2 mm (Figure 3-24)

Biliary Pathology

Extrahepatic Biliary Obstruction

- CBD measures greater than 6 mm in anterior to posterior intraluminal measurement.

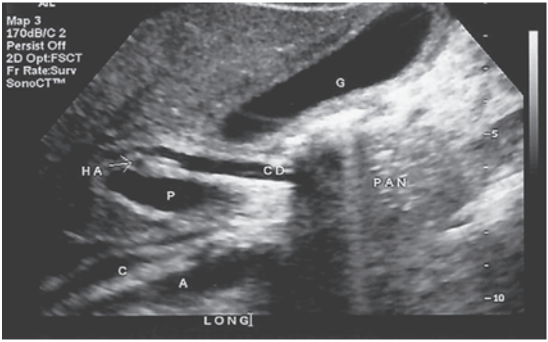


Figure 3-23 Normal common bile duct. Sagittal sonogram shows the portal vein (P) and the common bile duct (CD) anteriorly. HA—hepatic artery, C—inferior vena cava, A—aorta, PAN—head of pancreas, G—gallbladder.

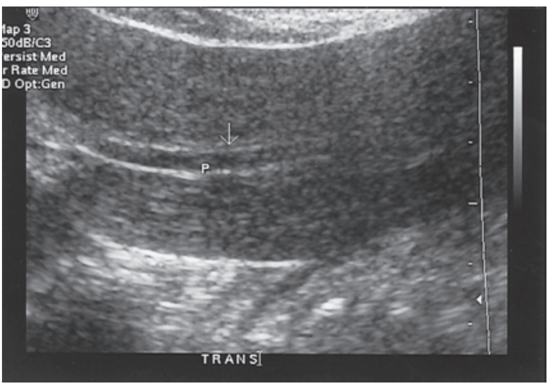


Figure 3-24 Normal intrahepatic bile ducts. A transverse section of the liver with portal vein (P) and intrahepatic bile duct (arrow) seen anterior to it.

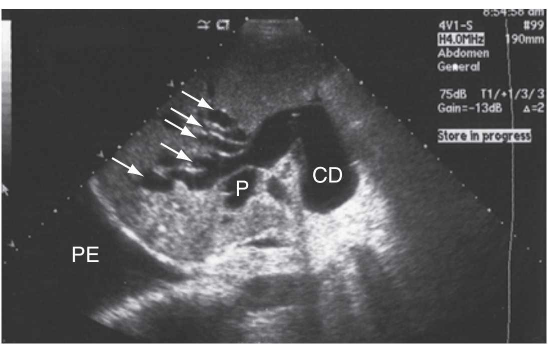
- Common causes include stones, tumor, or porta hepatis masses.
- Intrahepatic biliary obstruction may be present (see later in this section).

Intrahepatic Biliary Obstruction

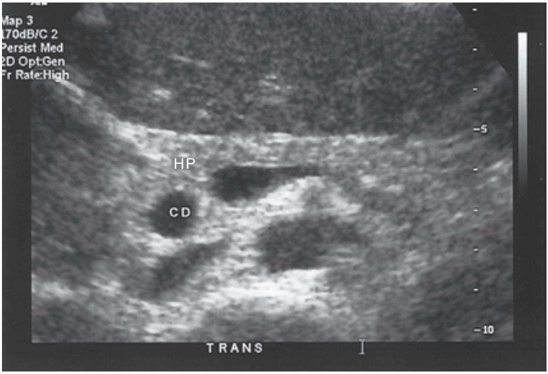
- Tubular, anechoic structures anterior to branching portal veins (Figure 3-25A–C)
- Measure greater than 2 mm intraluminal
- Must use color Doppler to distinguish between ducts and vessels

Choledocholithiasis (Common Bile Duct Stones)

- Echogenic foci within CBD (Figure 3-26)
- Posterior acoustic shadowing
- Most commonly seen near head of pancreas (ampulla of vater)
- The following can mimic CBD stones:
  - Air in adjacent bowel
  - Air in biliary tree (discussed later)
  - Surgical clips and stents
  - Right hepatic artery crossing common hepatic duct



(A)



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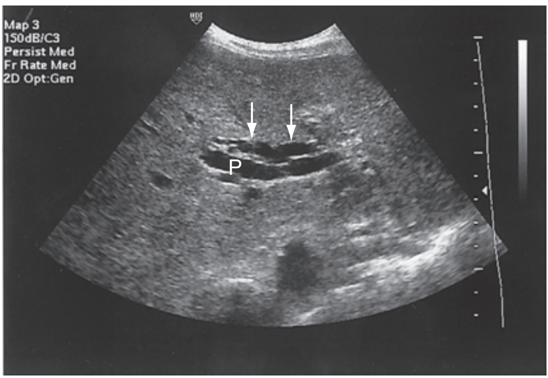


(C)

Figure 3-25A–C Extrahepatic and intrahepatic biliary dilation. In longitudinal (A), a dilated common bile duct (CD) is seen anterior to the portal vein (P). The intrahepatic biliary radicals (arrows) are also dilated. A large pleural effusion (PE) is incidentally noted. In transverse (B), the dilated common bile duct (CD) is seen posterior to the head of the pancreas (HP). In transverse (C), dilated intrahepatic ducts (arrows) are seen anterior to portal vein (p).

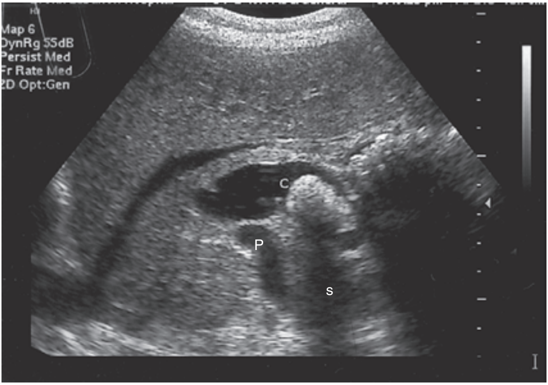


Figure 3-26 **Choledocholithiasis.** Longitudinal view of common bile duct (C) anterior to portal vein (P) with large stone casting posterior acoustic shadow(s).

Cholangiocarcinoma

- Low-level echoes in bile duct (Figure 3-27)
- Abrupt termination of common bile duct

Choledochal Cysts

- Cystic dilation of the common bile duct (Figure 3-28)
- Direct communication with CBD may or may not be seen on ultrasound.
- Appearance can mimic normal gallbladder.

Pneumobilia (Air in the Biliary Tree)

- Seen as linear, echogenic structures within liver (Figure 3-29)
- May have dirty shadow
- May be seen after biliary surgery

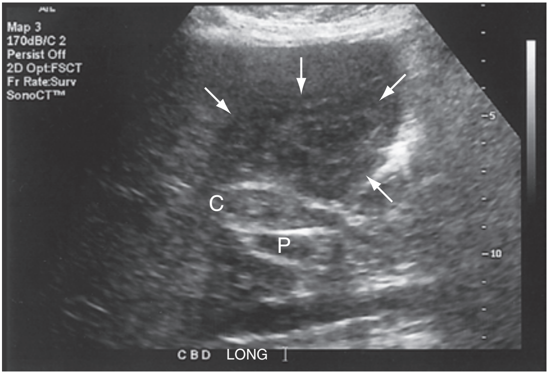


Figure 3-27 Cholangiocarcinoma. Low-level echoes are seen in the common bile duct (C) anterior to portal vein (P), which represents common bile duct carcinoma. Poorly defined liver mass (between arrows) is also demonstrated.

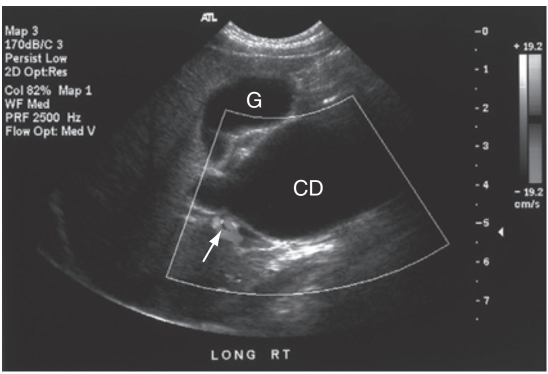


Figure 3-28 Choledochal cysts. A longitudinal sonogram demonstrates large choledochal cyst (CD) anterior to the portal vein (arrow). The gallbladder (G) is seen anterior to the choledochal cyst. No color Doppler flow was demonstrated within the cyst.

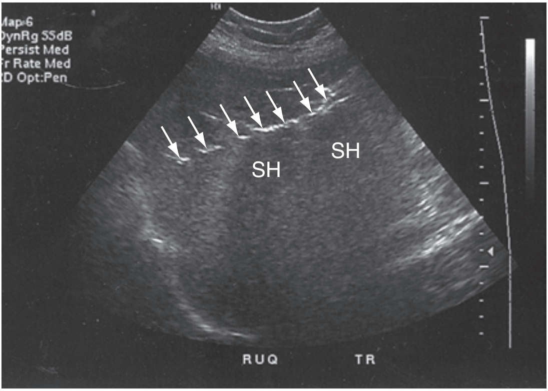


Figure 3-29 Pneumobilia. Transverse view of the liver with hyperechoic linear areas associated with shadowing in a patient with air in the biliary tree. Note the echoes within the shadowing (dirty shadowing), which is characteristic of air.

Chapter 4: The Pancreas

DUNSTAN ABRAHAM

Normal Sonographic Anatomy

- Divisions—head, body, and tail regions (best seen on transverse view) Landmarks surrounding the pancreas include aorta, inferior vena cava (IVC), splenic vein, superior mesenteric artery (SMA) and common bile duct (Figures 4-1 and 4-2A and B).
- Gland is isoechoic or hyperechoic when compared with normal liver echogenicity.
- Pancreas becomes more echogenic with age due to fatty infiltration.
- Main pancreatic duct (duct of Wirsung)
  - Anechoic and tubular when fluid filled (Figure 4-3)
  - Echogenic line when no fluid present
- Anechoic or echogenic stomach seen anterior to pancreas
- Anechoic fluid-filled duodenum may be seen lateral to head (Figure 4-4).
- Head of pancreas measures up to 3 cm in size.
- Pancreatic duct measures up to 2 mm in size.
- Anechoic posterior wall of stomach and splenic vein can mimic the pancreatic duct (Figure 4-5).

Pancreatic Pathology

Acute pancreatitis

- Can be diffuse or focal

Diffuse Pancreatitis

- Gland diffusely enlarged and hypoechoic (Figure 4-6)
- Dilated anechoic pancreatic duct (greater than 2 mm in size AP)

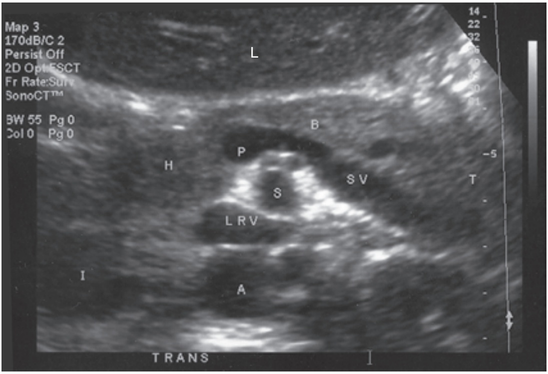


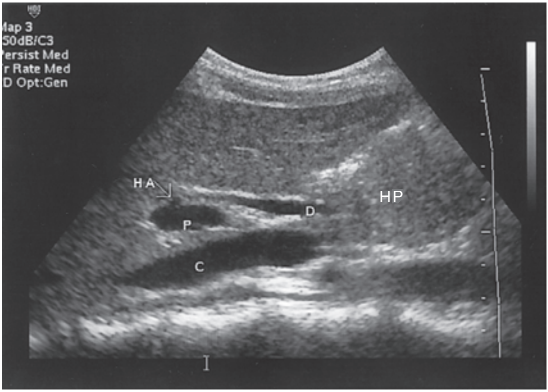
Figure 4-1 Normal pancreas. This transverse view shows the normal pancreas with head (H), body (B), and tail (T) regions. The gland is slightly more echogenic than the adjacent liver texture (L). The surrounding vascular landmarks are also demonstrated. SV—splenic vein, PS—portal splenic confluence, S—superior mesenteric artery, C—inferior vena cava, A—aorta, LRV—left renal vein.

Focal Pancreatitis

- Focal isoechoic or hypoechoic mass
- Commonly seen in head of pancreas
- May mimic adenocarcinoma (discussed later)
- Correlate with clinical or laboratory data

Complications of Acute Pancreatitis

- Major complication is pseudocyst formation.
  - Round or oval shape
  - Borders irregular or well defined
  - Most common appearance is anechoic mass with posterior enhancement (Figure 4-7A).
  - May be echogenic or complex on occasions (Figure 4-7B and C).
  - May develop calcifications and septations.
  - Locations of pseudocysts include lesser sac, anterior para-renal space, and within pancreas.



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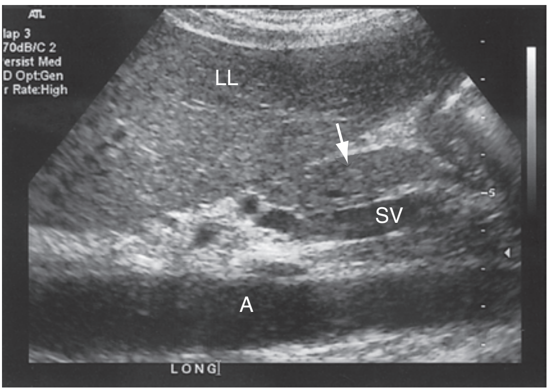


(B)

Figure 4-2A & B Normal pancreas sagittal views. In (A), the head of pancreas (HP) is seen with the common bile duct (D), which runs posterior to it. P—portal vein, C—inferior vena cava, and HA—hepatic artery. In (B), the body of the pancreas (arrow) is seen anterior to the splenic vein (SV) and aorta (A). The left lobe of liver (LL) is anterior to the pancreas.

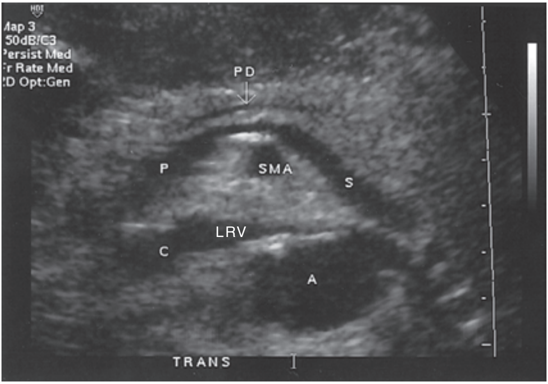


Figure 4-3 Main pancreatic duct. Transverse image of the pancreas with the anechoic duct of Wirsung (PD) centrally located. P—portal splenic confluence, S—splenic vein, SMA—superior mesenteric artery, LRV—left renal vein, A—aorta, and C—inferior vena cava.

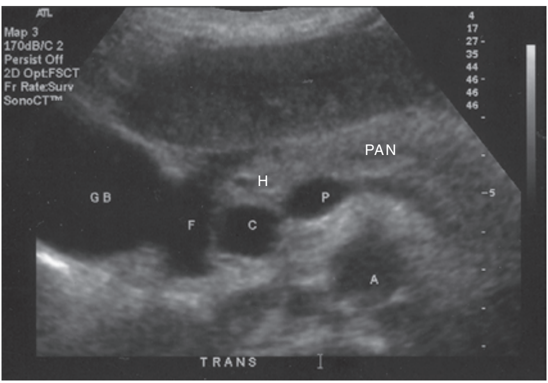


Figure 4-4 Pancreas with fluid-filled duodenum. Transverse view of the pancreas (PAN) with fluid-filled duodenum (F) lateral to the pancreatic head (H). GB—gallbladder, C—inferior vena cava, A—aorta, P—portal splenic confluence.

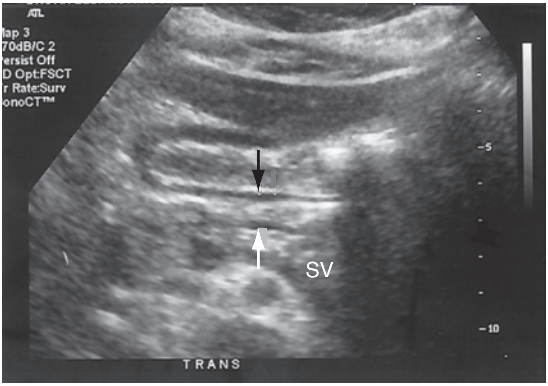


Figure 4-5 Mimics of pancreatic duct. A transverse image of the pancreas demonstrates a normal pancreatic duct (white arrow). The posterior wall of stomach (black arrow) and splenic vein (SV) may be commonly mistaken for the pancreatic duct.

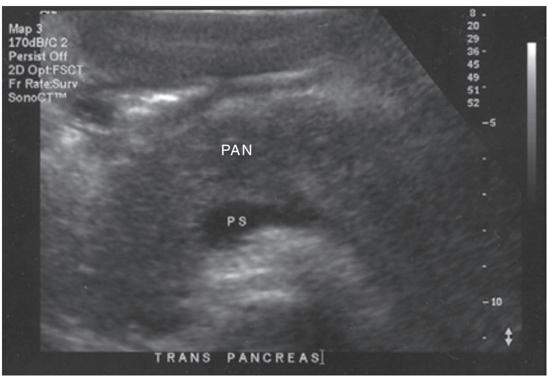


Figure 4-6 Acute pancreatitis. Transverse view of a patient with acute pancreatitis demonstrates an enlarged and hypoechoic gland (PAN). PS—portal splenic confluence.

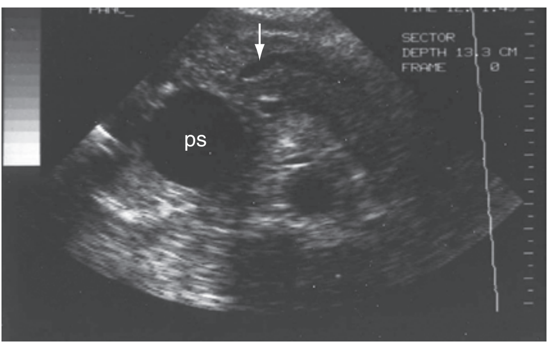
- Other complications and associated findings with pseudocyst
  - Pancreatic ascites (pseudocyst leakage) (Figure 4-8)
  - Pleural effusion
  - Abscesses
  - Vascular (venous or arterial thrombosis and pseudo aneurysms)
  - Color Doppler useful to evaluate vascular abnormalities

Chronic Pancreatitis

- Small echogenic gland
- Hyperechoic areas within pancreas (calcifications) (Figure 4-9A)
- Dilated anechoic pancreatic duct (Figure 4-9B)

Adenocarcinoma

- Hypoechoic solid mass; most commonly found in the head of gland (Figure 4-10)



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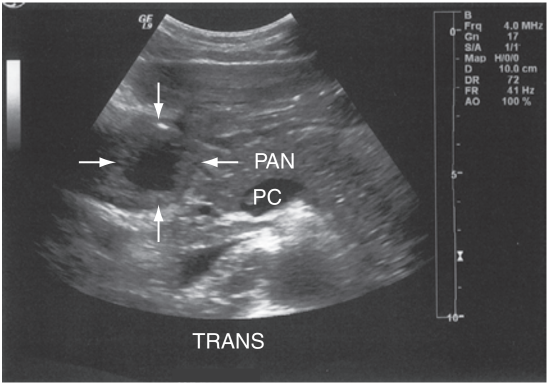

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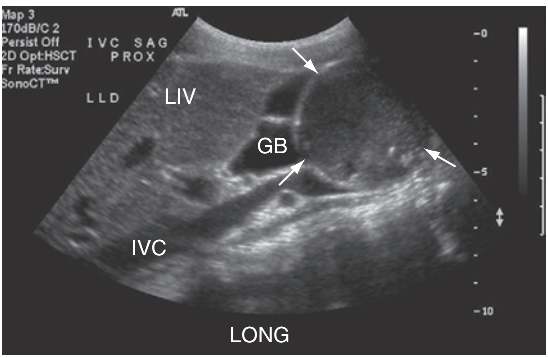


(C)

Figure 4-7A–C Pancreatitis with pseudocysts formation. In (A), a transverse view of the pancreas shows a pseudocyst (ps), which is anechoic with moderate enhancement. The pancreatic duct (arrow) is dilated. In (B), the pseudocyst is complex with an anechoic center and echogenic periphery (between arrows). PAN—pancreas, PC—portal splenic confluence. In (C), the pseudocyst (between arrows) has diffuse low-level echoes with some posterior enhancement. GB—gallbladder, IVC—inferior vena cava, LIV—liver.

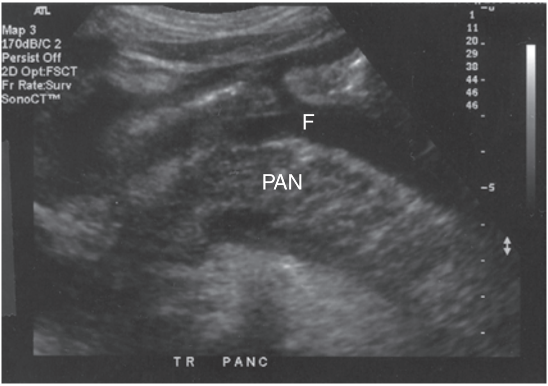
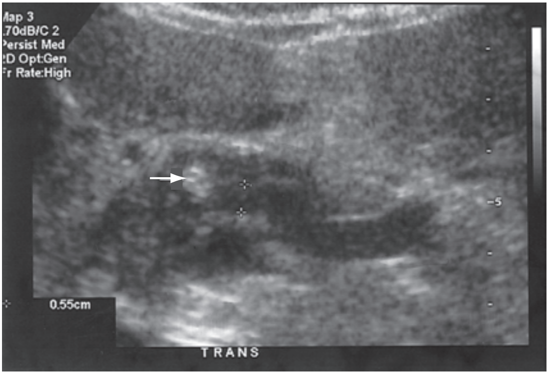


Figure 4-8 Pancreatic ascites. Transverse image shows an inflamed pancreas (PAN) with fluid (F) located anterior to the pancreas in the lesser sac.

- Tumors of body and tail less commonly seen (Figure 4-11)
- Loss of normal pancreatic parenchyma (Figure 4-12)
- Irregular pancreatic borders
- Hypoechoic peripancreatic lymph nodes (Figure 4-13), focal pancreatitis, and bowel loops of variable echogenicity may mimic a pancreatic tumor (Figure 4-14A and B).
- Associated findings:
  - Enlarged gallbladder (Courvoisier's sign)
  - Dilated bile ducts
  - Dilated pancreatic duct
  - Liver metastasis
  - Lymphadenopathy
  - Splenomegaly (due to compression of splenic vein by tumor in tail of pancreas)



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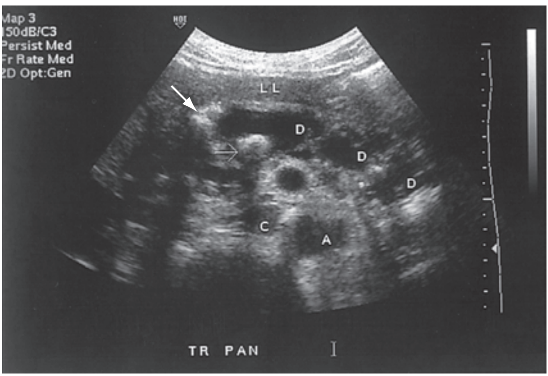


(B)

Figure 4-9A & B Chronic pancreatitis. (A) Demonstrates a tortuous and dilated main pancreatic duct (between calipers). A focal area of calcification (arrow) is also seen adjacent to the pancreatic duct. In (B), the pancreatic duct (D) is dilated with intraductal calcifications (arrows). Note the absence of normal pancreatic tissue. LL—left lobe of the liver, C—inferior vena cava, A—aorta.

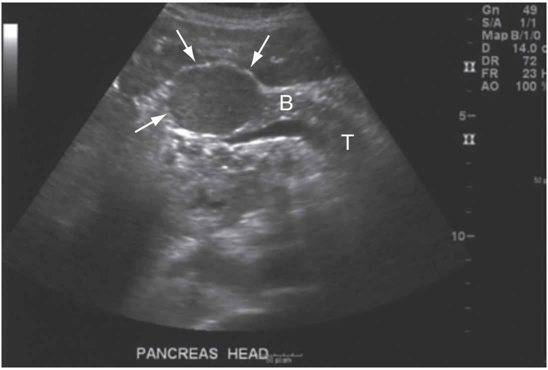


Figure 4-10 Adenocarcinoma in head of pancreas. Transverse image of pancreas with large hypoechoic mass (between arrows) in head representing adenocarcinoma. B—body of pancreas and T—tail of pancreas.

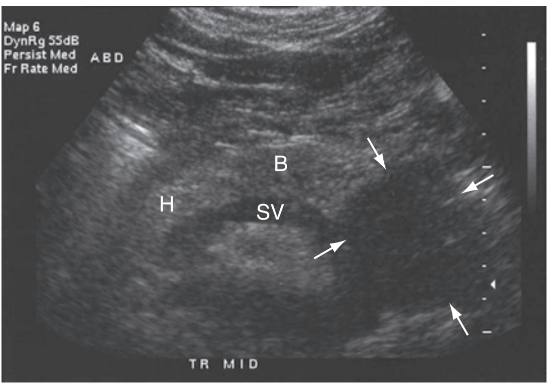


Figure 4-11 Adenocarcinoma in tail of pancreas. Transverse image of the pancreas with large hypoechoic tumor in the tail (between arrows). H—head of pancreas, B—body of the pancreas, SV—splenic vein.

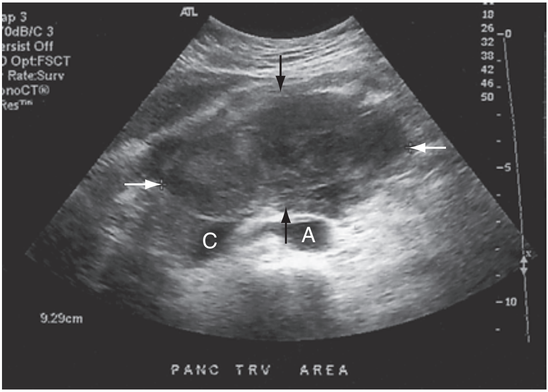


Figure 4-12 Pancreatic adenocarcinoma. Transverse view shows a large hypoechoic mass (between arrows) replacing normal pancreatic tissue. The aorta (A) and the inferior vena cava (C) are the only vascular landmarks identified.

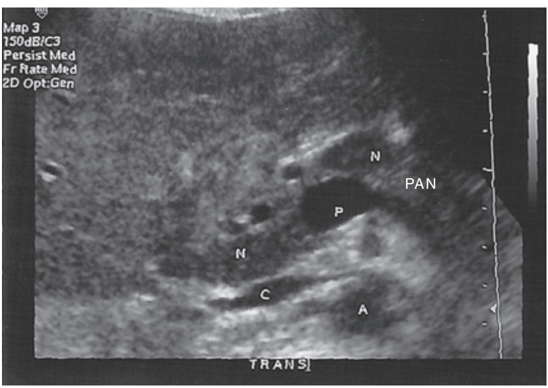
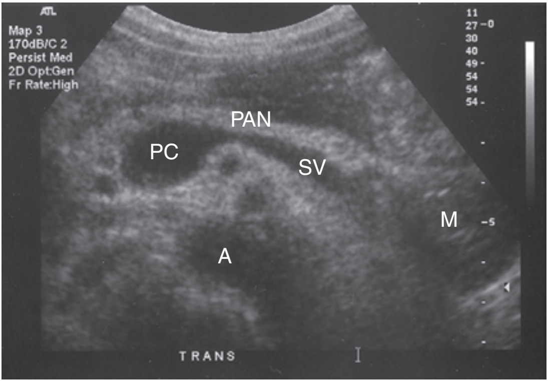
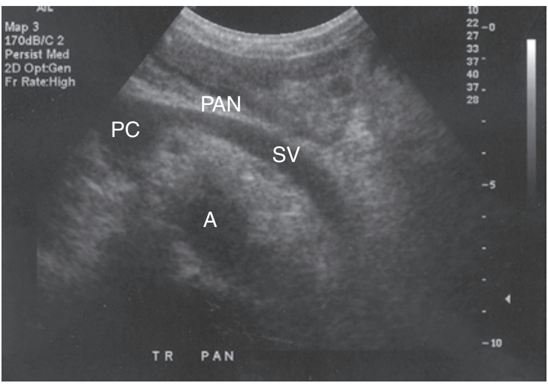


Figure 4-13 Peripancreatic nodes mimicking pancreatic mass. Peripancreatic lymph nodes (N) are seen in a patient with AIDS. The presence of similar masses in other areas of the abdomen made the diagnosis of pancreatic cancer less likely. PAN—pancreas, C—inferior vena cava, A—aorta.



(A)



(B)

Figure 4-14A & B Bowel mimicking pancreatic tail mass. In (A), a hypoechoic mass (M) is seen in the region of the tail of pancreas. In (B), taken after 15 minutes, the mass is no longer apparent. This finding is consistent with normal loops of bowel that may demonstrate peristalsis, although not in this case. PAN—pancreas, PC—portal splenic confluence, SV—splenic vein, A—aorta.

Cystadenoma and Cystadenocarcinomas

- Cystic masses
- May contain septations and internal echoes
- Most commonly located in body and tail of pancreas
- Anechoic or hypoechoic stomach may mimic cystic pancreatic tumor.

Chapter 5: The Abdominal Aorta and Inferior Vena Cava

DUNSTAN ABRAHAM

Normal Sonographic Anatomy

The Abdominal Aorta

- Tubular, anechoic structure
- Located left of midline and adjacent to inferior vena cava (IVC)
- Tapers inferiorly and demonstrates pulsatility
- Measures less than 3 cm in anterior to posterior diameter intraluminally
- Visible branches include celiac axis (with hepatic and splenic branches), superior mesenteric artery (SMA), renal arteries, inferior mesenteric artery (IMA), gonadal arteries, and common iliac arteries (Figure 5-1A–D).
- Maximum diameter of common iliac arteries is 1.5 cm for men and 1.2 cm for women.

Inferior Vena Cava

- Tubular anechoic structure
- Located right of midline
- Size varies with respiration

Major Distinguishing Features Between Aorta and Inferior Vena Cava on Sonography

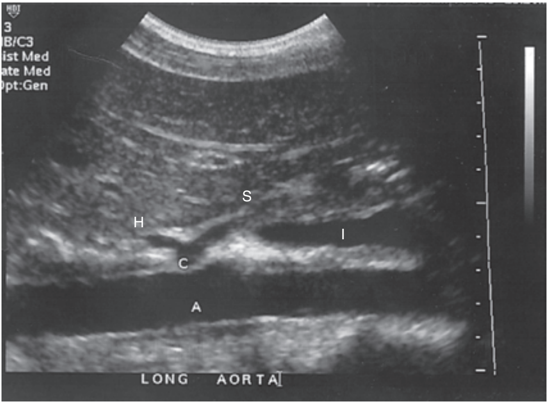
- Aorta located left of midline; IVC located right of midline
- Aorta flow pulsatile; IVC flow nonpulsatile
- Aorta tapers distally; IVC varies in caliber (dilates with valsalva)
- Aorta follows curvature of spine; IVC has cephalic dip (Figure 5-2)

- Aorta has multiple anterior and lateral branches along vessel (discussed previously); major tributaries of IVC are hepatic veins best seen on transverse view (Figure 5-3).

Pathology

Aneurysm

- Types include
  - Fusiform (uniform dilation)
  - Saccular (focal dilation)
  - Dissecting (tear in intimal lining)
- Fusiform and saccular types
  - Vessel diameter greater than 3 cm (Figures 5-4 and 5-5)
  - Aneurysms may also involve celiac axis, SMA, renal arteries, and common iliac arteries.
  - Low-level echoes in walls represent thrombus (Figure 5-6).
  - Above may be missed at low gain setting.
  - Reverberation echoes on anterior wall may mimic thrombus.
  - Complex fluid collections adjacent to the aneurysm may represent rupture.
  - Light transducer pressure should be applied when aneurysm is suspected.
- Dissecting aneurysm
  - Echogenic linear structure within vessel represents intimal flap (Figure 5-7).
  - Color Doppler demonstrates flow in both channels.
- Liquefaction of thrombus may mimic pseudodissection.
- Color Doppler flow not seen in both lumens with pseudodissection
- Grafts identified by linear parallel echoes within aorta and iliac vessels (Figure 5-8)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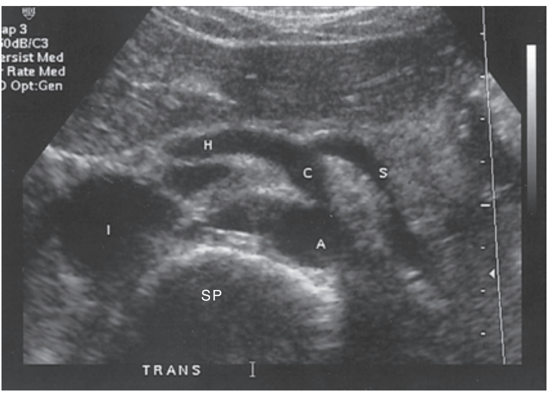
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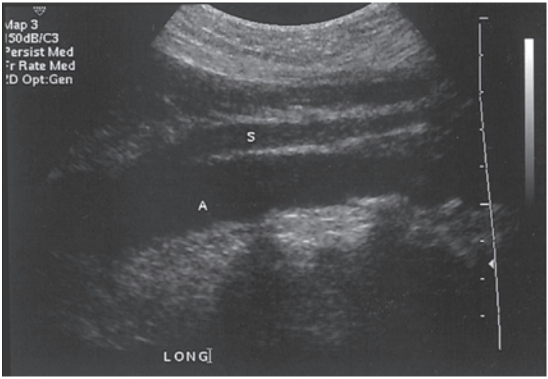

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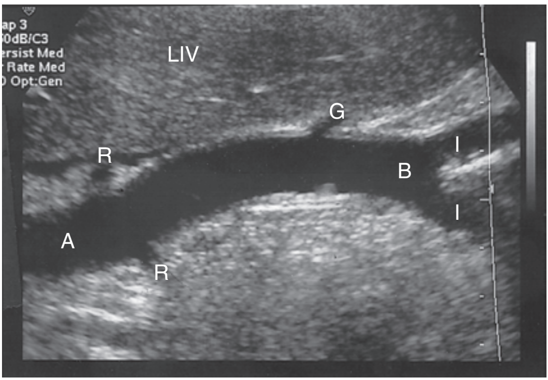


(D)

Figure 5-1D Normal aorta and branches. In (A) longitudinal view of the normal abdominal aorta (A) demonstrates the celiac axis (C) and its branches hepatic artery (H) and splenic artery (S). I—inferior vena cava. (B) The transverse view of the aorta (A) shows the celiac axis (C) with branches hepatic artery (H) and splenic artery (S). I—inferior vena cava, SP— spine. (C) The longitudinal view shows the aorta (A) with superior mesenteric artery (S) branching anteriorly and coursing parallel to the aorta. (D) A coronal view of the aorta (A) with the patient in a left lateral decubitus position demonstrates lateral branches, renal arteries, (R) and gonadal arteries (G). The bifurcation of the aorta with right and left iliac arteries (I).

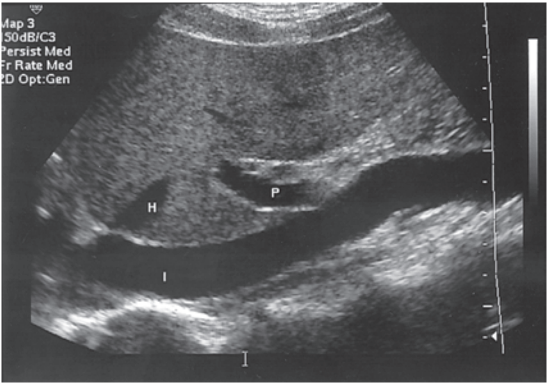


Figure 5-2 Inferior vena cava. A longitudinal image of the inferior vena cava (I) shows the proximal cava with a slight anterior curve (cephalic dip). H—hepatic vein and P—portal vein.

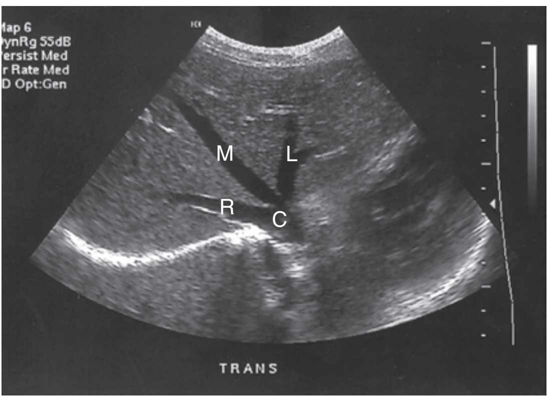


Figure 5-3 Hepatic veins. Transverse image of the liver with right (R), middle (M), and left (L) hepatic veins draining into inferior vena cava (C).

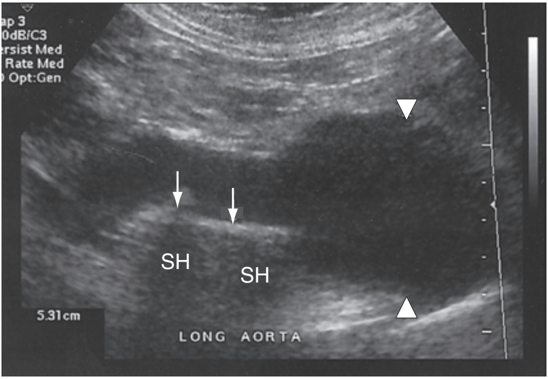


Figure 5-4 Fusiform aneurysm of the abdominal aorta. A longitudinal view of the abdominal aorta shows dilation of the aorta (between arrowheads) measuring 5.31 cm from anterior to posterior. Plaque (arrows) with acoustic shadowing (SH) is also identified along the wall of the aorta.

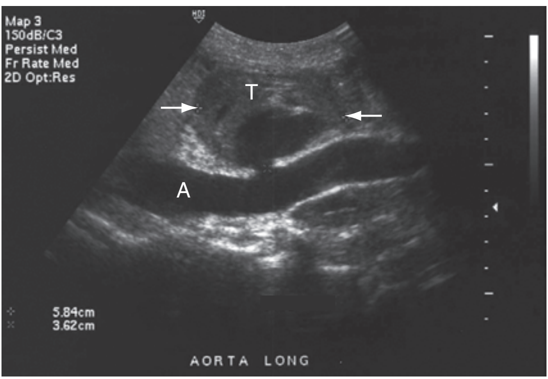


Figure 5-5 Saccular aneurysm of the abdominal aorta. Sagittal image of abdominal aorta (A) with saccular aneurysm (between arrows). Thrombus (T) is seen as low-level echoes within the aneurysm

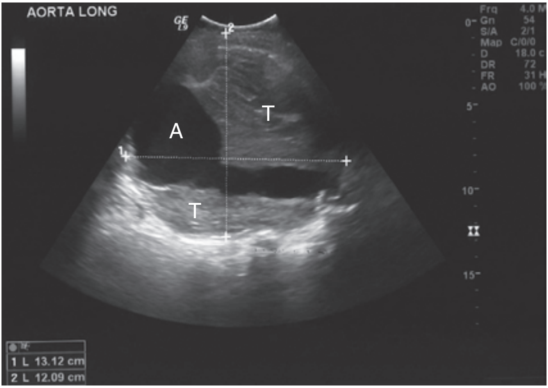


Figure 5-6 Fusiform aneurysm with thrombus. Limited sagittal view of aneurysm with thrombus. The anechoic lumen of the aorta (A) can be distinguished from echogenic thrombus (T) within the wall.

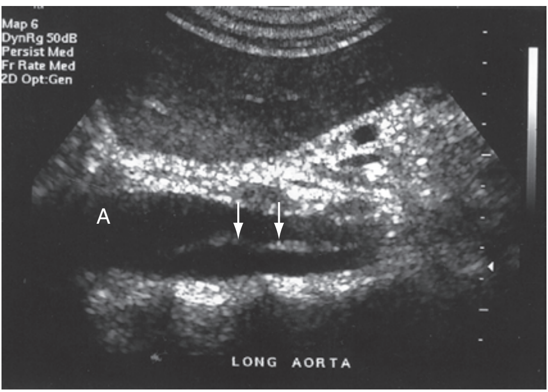


Figure 5-7 Aortic dissection. The hyperecholic intimal flap (arrows) is visible within the lumen of the aorta (A) in this patient with aortic dissection.

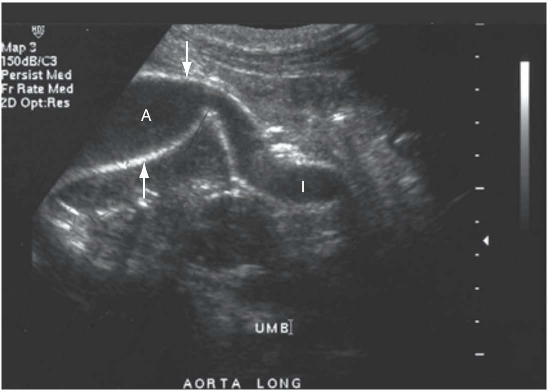


Figure 5-8 Aortic graft. Limited longitudinal view of aorta (A) iliac artery (I) shows hyperechoic walls (arrows) of graft.

Chapter 6: The Kidneys and Urinary Bladder

DUNSTAN ABRAHAM

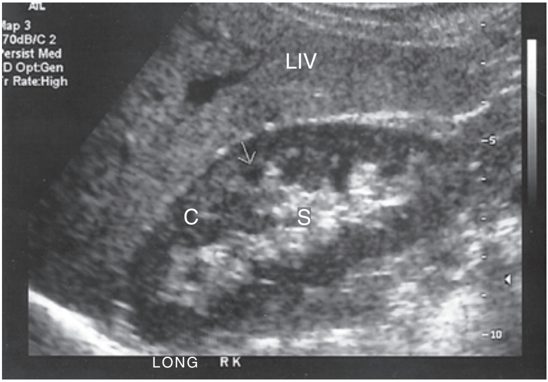
The Kidneys

Normal Sonographic Anatomy

- Measures 9–12 cm in length
- Outer cortex has medium-level echoes (less echogenic compared to normal liver texture); inner renal sinus is hyperechoic (Figure 6-1A).
- Medullary pyramids seen as anechoic to hypoechoic structures with triangular shape (Figure 6-1B)

Normal Variants and Congenital Anomalies

- Dromedary hump
  - Cortical bulge more common on lateral aspect of left kidney (Figure 6-2)
  - Bulge isoechoic to kidney
  - Can mimic renal mass
  - Scanning patient in different positions may help to distinguish normal cortical bulge from tumor (tumor will persist in different scanning projections).
- Column of Bertin
  - Cortical tissues projecting between pyramids (Figure 6-3)
  - Isoechoic to cortex
  - Can mimic collecting system mass
- Junctional parenchymal defect
  - Hyperechoic, triangular area seen in upper/mid poles (Figure 6-4)
  - Commonly seen on right kidney
  - May mimic a fatty tumor (e.g., angiomyolipoma)
- Horseshoe kidney
  - Fusion of kidneys
  - More commonly seen in lower poles (Figure 6-5)



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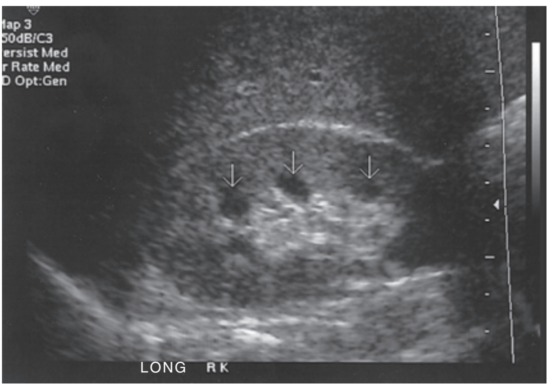


(B)

Figure 6-1A & B Normal kidney. In longitudinal (A), the outer cortex (C) has medium-level echoes compared with the inner sinus (S), which is hyperechoic. The cortex of the kidney is less echogenic than the normal liver (LIV). The arrow represents a renal pyramid. (B) Renal pyramids are seen as multiple anechoic structures (arrows) on the corticomedullary junction.

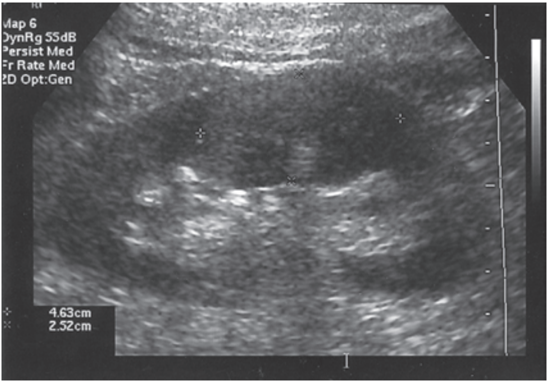


Figure 6-2 Dromedary hump. A longitudinal image of the left kidney shows cortical bulge (between markers). Although this appearance may mimic a tumor, scanning the patient in different projections will show disappearance of the dromedary hump.

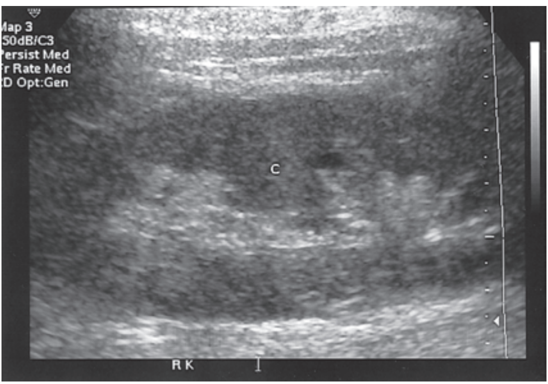


Figure 6-3 Column of Bertin. A longitudinal scan demonstrates prominent renal column (C), which is isoechoic to the adjacent cortex. This appearance can be mistaken for transitional cell carcinoma.

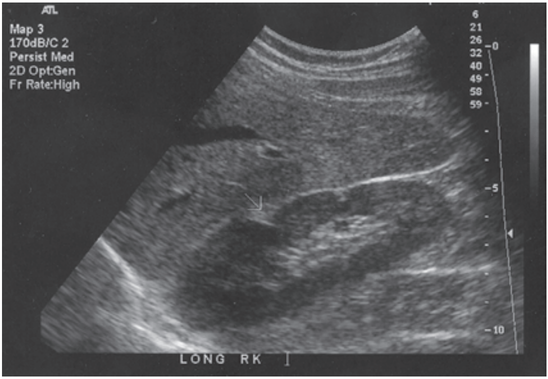


Figure 6-4 Junctional defect. A triangular echogenic area (arrow) is seen on anterior aspect of the kidney representing a junctional defect. This appearance can mimic an echogenic mass.

Figure 6-5 Horseshoe kidney. Transverse sonogram showing fusion of kidneys at the lower pole. RK—right kidney, LK—left kidney.

- Fusion best demonstrated on a transverse view anterior to aorta
- Medial orientation of both kidneys on a sagittal view is suspicious for horseshoe anomaly.

- Duplex collecting system
  - Two echogenic renal sinuses separated by cleft of tissue isoechoic to renal cortex (Figure 6-6)
- Pelvic kidney
  - Ectopic kidney located in pelvis (Figure 6-7)
  - May mimic solid pelvic mass
  - Renal vessels seen anteriorly due to malrotation
  - Must document absence of kidney in renal fossa of affected side

Renal Pathology

Cystic Masses

Cortical Cysts

- Can be single or multiple masses (Figure 6-8A and B)

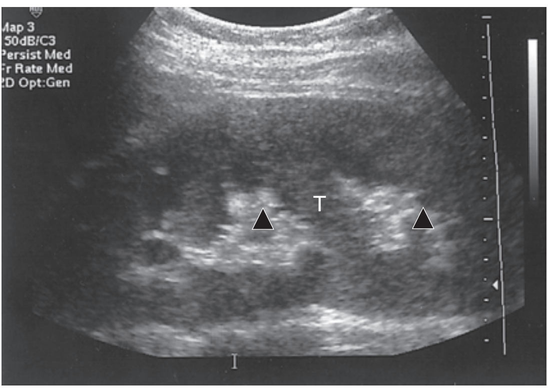


Figure 6-6 Duplex collecting system. A sagittal sonogram shows kidneys with two echogenic renal sinuses (▲) separated by cleft of tissue. (T)

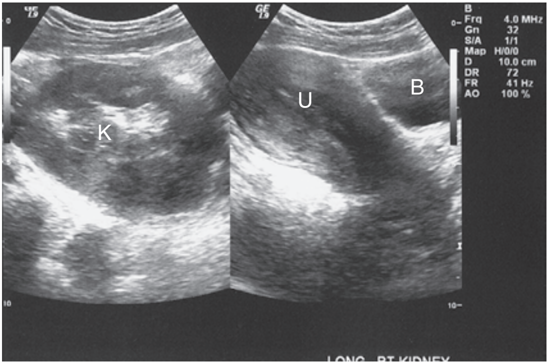
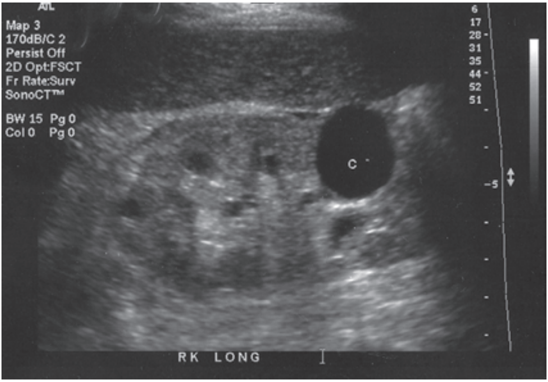


Figure 6-7 Pelvic kidney. Compound sagittal sonogram of the pelvis showing pelvic kidney (K) superior to the urinary bladder (B) and uterus (U) in a female patient. This can be mistaken for a pelvic mass.

- Round or oval shape
- Anechoic, smooth walls with posterior enhancement
- Complex cysts may have septations and/or internal echoes caused by hemorrhage, infection, calcification, or less commonly tumor (Figure 6-9A and B).
- Bilateral multiple cortical renal cysts can be mistaken for polycystic kidney disease (discussed later).

Parapelvic Cysts

- Located in renal sinus (Figure 6-10)
- Round or oval shaped
- Anechoic, smooth walls with posterior enhancement
- May be complex with internal echoes
- Hydronephrosis and renal artery aneurysm may mimic parapelvic cyst
- Pulse or color Doppler can identify renal artery aneurysm.



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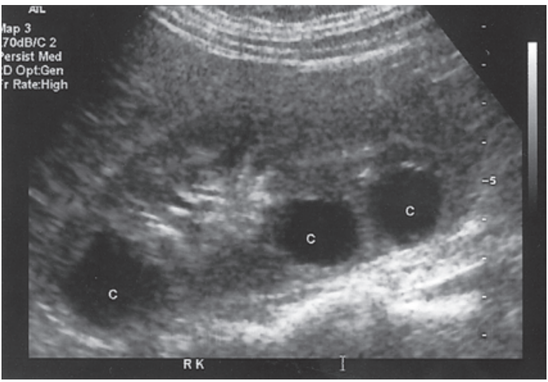
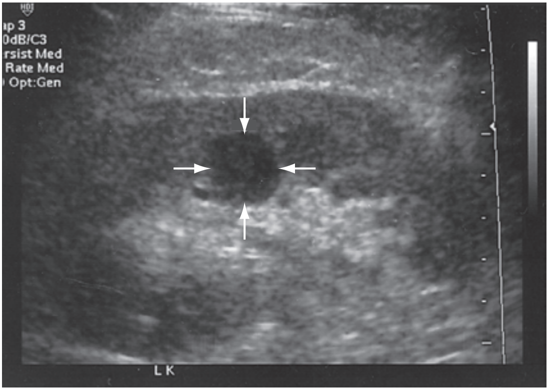
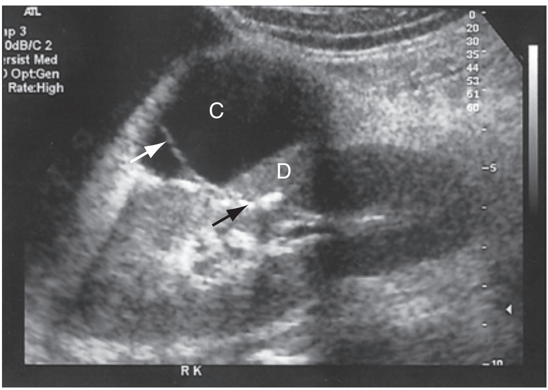


(B)

Figure 6-8A & B Benign cortical renal cyst. In (A), a sagittal scan shows a solitary anechoic cortical cyst (c) with smooth borders and enhancement in lower pole of kidney. In (B), multiple cortical cysts (C) are shown. This appearance should not be mistaken for polycystic kidney disease in which cysts are bilateral and of different sizes.



(A)



(B)

Figure 6-9A & B Complex renal cyst. In (A), low-level echoes are seen within the renal cyst (between arrows). These echoes could be easily missed at low gain setting. In (B), a sagittal scan shows renal cyst (C) with septation (white arrow), echogeneic debris (D), and calcifications with shadowing (black arrow) that represent milk of calcium.

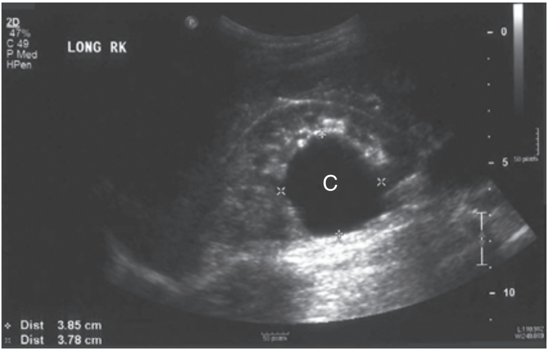


Figure 6-10 Parapelvic Renal Cyst. Sagittal image shows an anechoic cyst (C) within the renal collecting system. Although this appearance can mimic hydronephrosis, its rounded configuration is more suggestive of a cyst.

Adult Polycystic Kidney Disease

Early Stage

- Enlarged kidneys with multiple cysts of various sizes
- Random distribution throughout renal cortex bilaterally (Figure 6-11A and B)
- Bilateral multiple cortical renal cysts must not be mistaken for polycystic kidney disease.

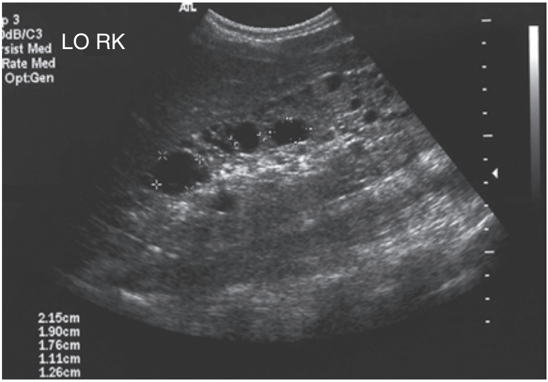
Late Stage

- Multiple cysts replacing renal parenchyma
- Loss of renal cortex seen with advanced disease (Figure 6-12)
- Cysts may be complex (echoes within cysts) and have hyperechoic walls caused by calcification
- Associated findings include liver and splenic cysts.

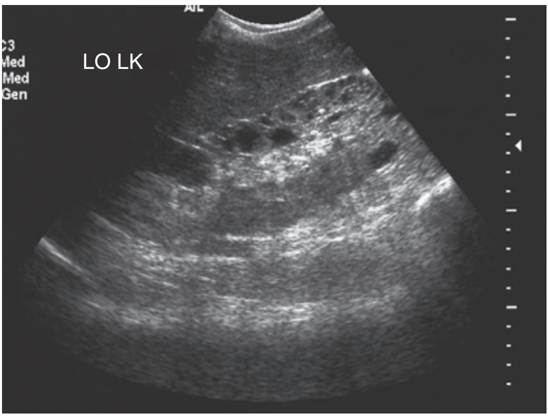
Benign Neoplasms

Angiomyolipoma

- Hyperechoic, homogeneous well-defined mass (Figure 6-13)



(A)



(B)

Figure 6-11A & B Early stage adult polycystic kidney disease. Both kidneys are equally enlarged with multiple cysts of varying sizes throughout the cortex.

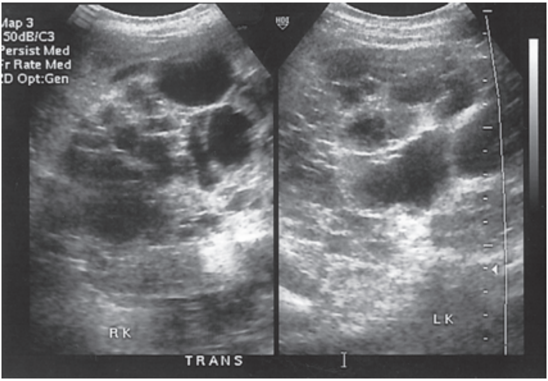


Figure 6-12 Late-stage polycystic liver disease. Transverse views demonstrate that renal parenchyma is replaced by multiple cystic masses bilaterally. Some cysts are irregular in configuration with low-level echoes.

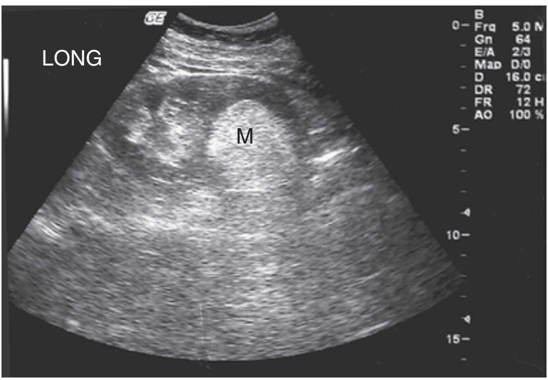


Figure 6-13 Angiomyolipoma. A hyperechoic well-defined mass (M) occupies the lower pole of the kidney. This was confirmed to be an angiomyolipoma on surgery.

- Single or multiple
- May have echogenic calcification
- Anechoic areas due to cystic degeneration

Lipomas

- Well-defined echogenic mass
- Usually less than 5 cm in diameter

Oncocytoma

- Isoechoic, hypoechoic, or hyperechoic mass (Figure 6-14)
- Well-defined or poorly defined
- Size generally less than 5 cm
- Hemorrhage and calcification uncommon
- May mimic renal cell carcinoma

Malignant Neoplasms

Renal Cell Carcinoma (Hypernephroma)

- Cystic, solid, or complex cortical mass (Figure 6-15A–C)
- Hyperechoic areas within mass due to calcifications
- Tumor may partially or completely replace the normal renal cortex (Figure 6-15D).

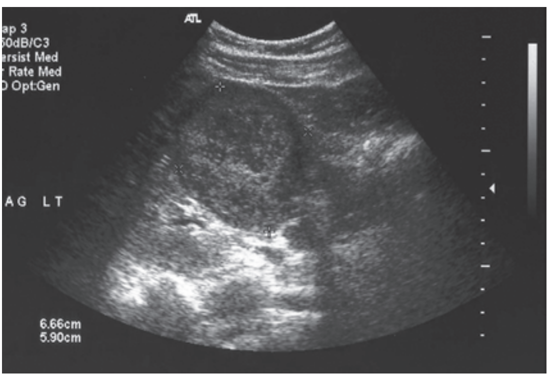
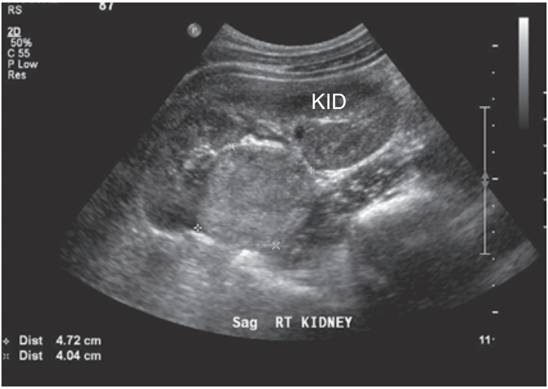
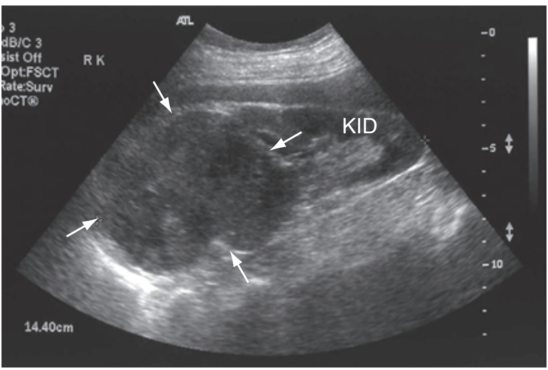


Figure 6-14 Oncocytoma. A sagittal scan shows a large midpole heterogeneous mass (between markers) that proved to be an oncocytoma on surgery. This appearance is indistinguishable from renal cell carcinoma.


RS
2D
50%
C 55
P Low
Res
KID
Sag RT KIDNEY
Dist 4.72 cm
Dist 4.04 cm
11

(A)


ATL
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KID
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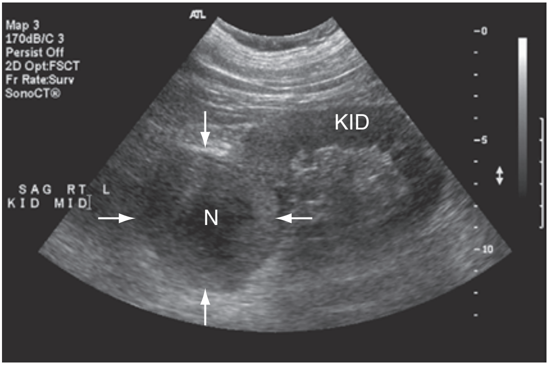
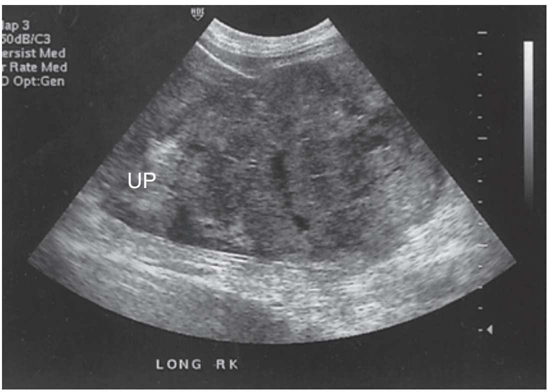
10
14.40cm

(B)



(C)



(D)

Figure 6-15A–D Renal cell carcinoma. In (A), the tumor (between calipers) is hyperechoic to the renal cortex (KID). In (B), the tumor (between arrows) is large, hypoechoic, and slightly lobular in contour. It occupies the upper pole of the kidney (KID). In (C), a complex mass (between arrows) is noted on the superior aspect of the kidney (KID). The central anechoic area (N) represents cystic necrosis. In (D), the renal parenchyma is almost completely replaced by the tumor mass. A thin section of the upper pole of the kidney (UP) is visualized.

- Low-level echoes in renal vein and inferior vena cava may represent tumor (Figure 6-16).
- Dromedary hump, solid benign masses, complex cysts, and large adrenal masses may mimic renal cell carcinoma (Figure 6-17).

Transitional Cell Carcinoma

- Isoechoic or hypoechoic mass in collecting system (Figures 6-18 and 6-19A and B)
- Low-level echoes in renal vein and inferior vena cava may represent tumor.
- Column of Bertin may mimic transitional cell carcinoma.

Renal Calculi

- Echogenic foci within kidneys (Figure 6-20)
- Posterior acoustic shadowing
- Staghorn calculi extends from upper to lower pole (Figure 6-21).

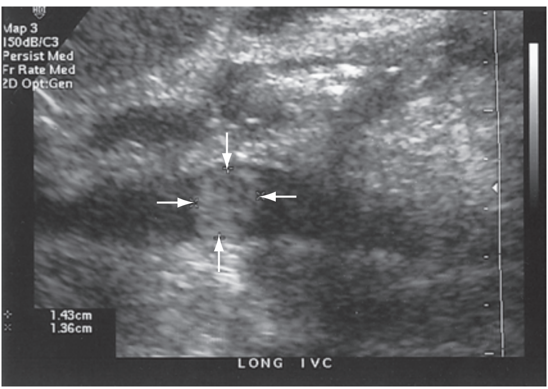


Figure 6-16 Inferior vena cava tumor thrombus. A longitudinal image of the inferior vena cava in a patient with renal cell carcinoma shows echogenic tumor (between arrows).

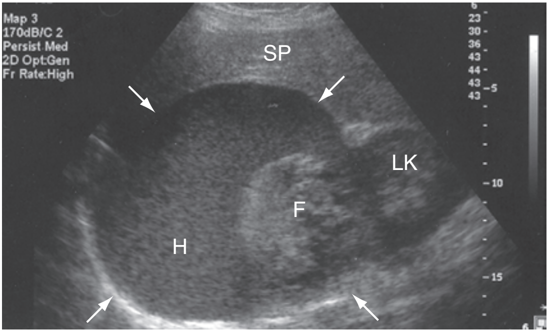


Figure 6-17 Adrenal myelolipoma mimicking a renal mass. A sagittal sonogram demonstrates a large heterogeneous adrenal mass (arrows) superior to the left kidney (LK). It contains a central echogenic area (F) representing fat and a fluid area (H) with low-level echoes representing hemorrhage. Large adrenal masses are often indistinguishable from renal masses. SP—spleen.

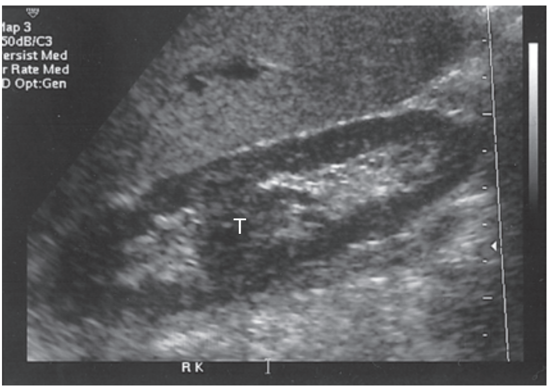
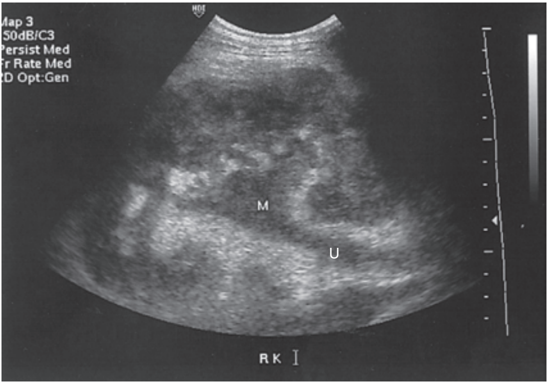
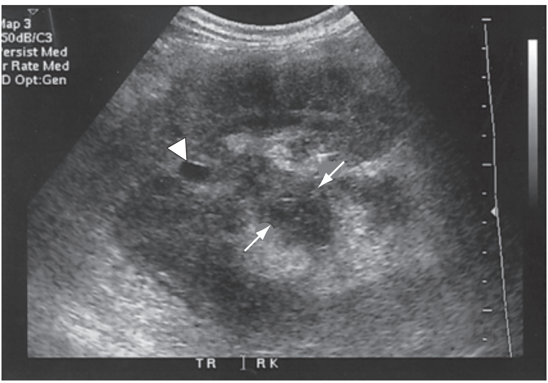


Figure 6-18 Transitional cell carcinoma. A sagittal view of the kidney shows a hypoechoic mass (T) in the collecting system representing transitional cell carcinoma. This should not be mistaken for a prominent column of Bertin or a duplex collecting system.



(A)



(B)

Figure 6-19A & B Transitional cell carcinoma. A longitudinal view in (A) shows low-level echoes representing a soft tissue mass (M) filling the renal pelvis and ureter (u). In (B), a transverse image again shows the tumor within the collecting system (between arrows). Arrowhead points to a small cortical renal cyst

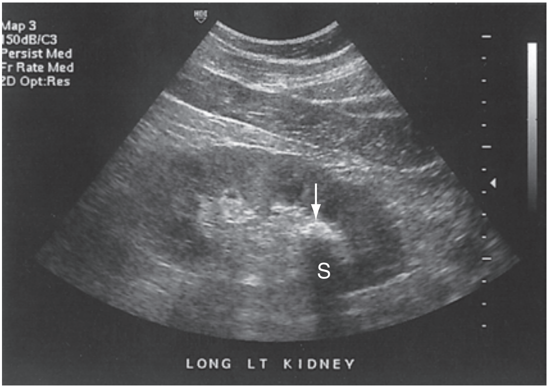


Figure 6-20 Renal calculus. A sagittal view of the kidney shows hyperechoic calculus (arrow) with acoustic shadowing (S) posteriorly.

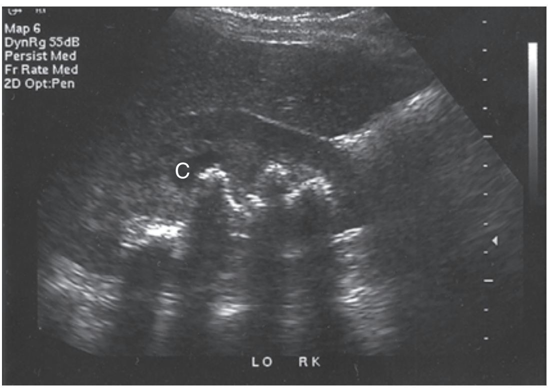


Figure 6-21 Staghorn calculi. A longitudinal image shows multiple hyperechoic foci with posterior shadowing extending from upper to lower pole. Associated caliectasis (c) is also present.

- Calculi in collecting system may cause hydronephrosis (discussed later in this section) (Figure 6-22).
- The following may mimic renal calculi: intrarenal gas, renal artery calcification, calcified tumor, and ureteral stent (Figure 6-23A and B).

Medullary Sponge Kidney

Sonographic Findings When Associated with Nephrocalcinosis

- Echogenic medullary pyramids (Figure 6-24A and B)
- Shadowing may or may not be present.

Hydronephrosis

- Communicating anechoic fluid areas within renal collecting system
- Posterior enhancement

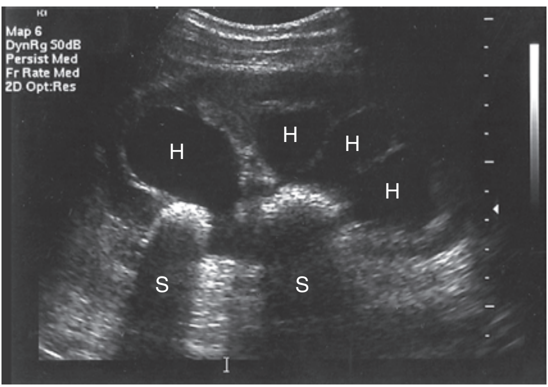
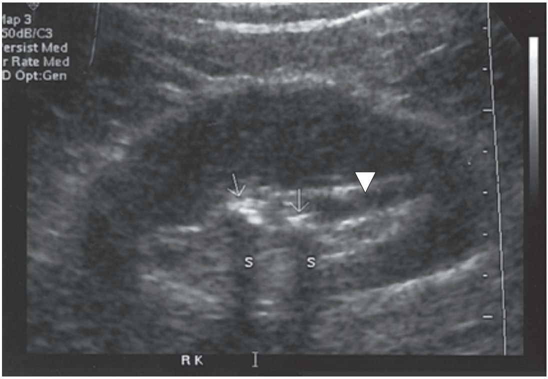
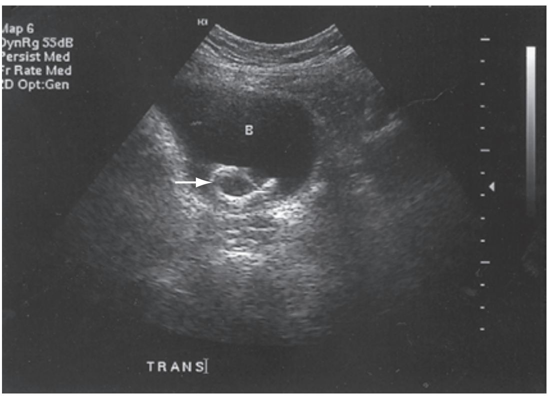


Figure 6-22 Renal calculi with hydronephrosis. Hyperechoic renal stones with shadowing (S) dilate the collecting system causing hydronephrosis. (H)

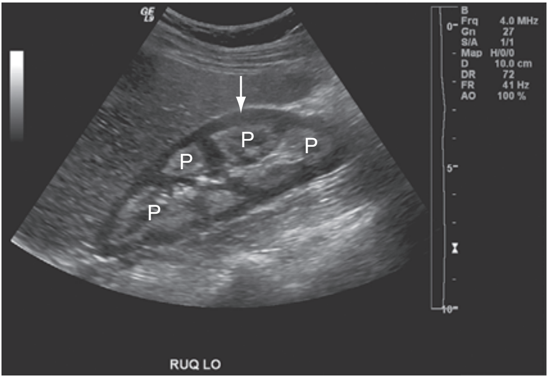


(A)

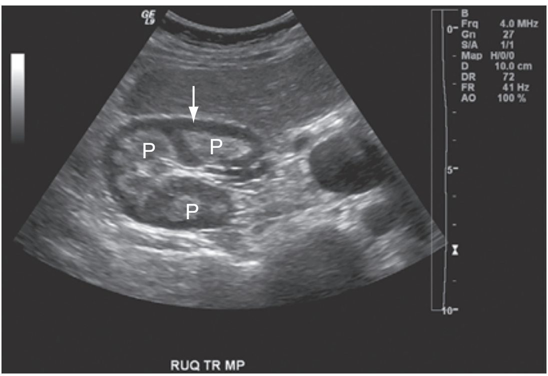


(B)

Figure 6-23A & B Ureteral stent mimicking renal calculi. A longitudinal view demonstrates hyperechoic ureteral stent (arrows) with acoustic shadowing (S) within the collecting system. This appearance can mimic renal calculi. The arrowhead indicates minimal dilation of the collecting system. In (B), the distal end of the stent (arrow) is seen in the urinary bladder (B).



(A)



(B)

Figure 6-24A & B Nephrocalcinosis secondary to medullary sponge kidney. Longitudinal (A) and transverse (B) demonstrates increase echogenicity in the region of the pyramids (P), which are more echogenic compared with the thin hypoechoic renal cortex (arrow).

- Classifications: grade 1 (mild), grade 2 (moderate), and grade 3 (severe) (Figure 6-25A–C)
- Dilated ureter may be also seen (Figure 6-26).
- Color Doppler should be used to distinguish between dilated ureter and vessel.
- Ureteral jets seen as flashing echogenic appearance in bladder which dissipates (see bladder section of this chapter)
- Presence of jets indicates nonobstructive ureter.
- Hydronephrosis may be caused by an overdistended urinary bladder that commonly resolves after voiding.
- Mimics of hydronephrosis include parapelvic renal cyst, renal vessels, and extrarenal pelvis.

Renal infection

Pyonephrosis

- Hydronephrosis with low-level echoes (pus)
- Decreased posterior acoustic enhancement

Pyelonephritis

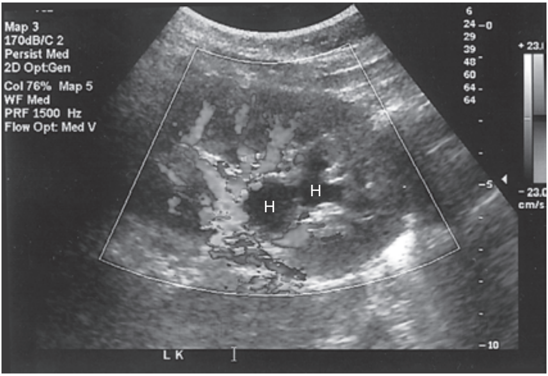
- Kidneys normal size or enlarged
- Hypoechoic or hyperechoic due to edema or hemorrhage
- Cystic, solid, or complex cortical mass may represent abscess (Figure 6-27A and B).
- Above may mimic cortical renal tumor.

Emphysematous Pyelonephritis

- Kidneys unilaterally enlarged and hypoechoic
- Echogenic foci (air) with dirty shadows seen in collecting system (Figure 6-28)

Xanthogranulomatous Pyelonephritis

- Enlarged kidney with multiple hypoechoic areas may represent dilated calyces or abscess.
- Large calculi with shadowing in collecting system
- Hydronephrosis present


Map 3
170dB/C 2
Persist Med
2D Opt:Gen
Col 76% Map 5
WF Med
PRF 1500 Hz
Flow Opt: Med V
H
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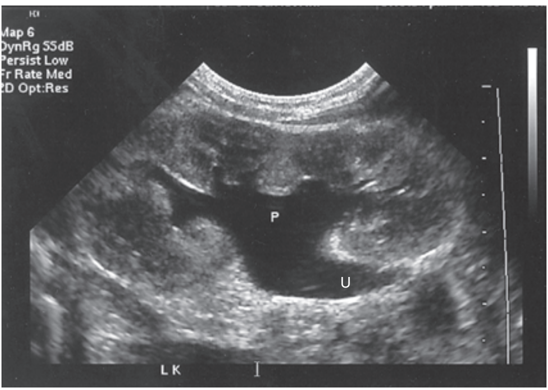
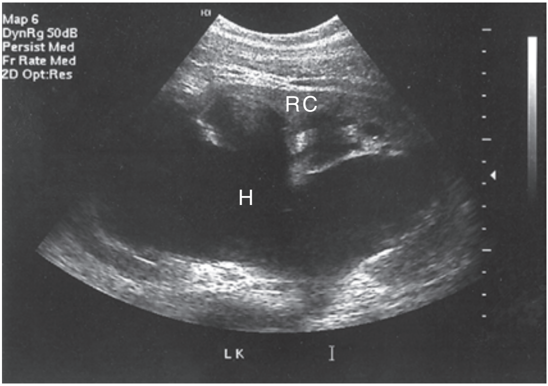
(A)


P
U
LK

(B)



(C)

Figure 6-25A–C Hydronephrosis. Longitudinal (A–C) showing three grades of hydronephrosis. A—grade 1 hydronephrosis—small anechoic areas within collecting system (H) represents mild hydronephrosis. Color Doppler proves that they are not vascular structures (see color inserts). B—grade 2 hydronephrosis—moderate communicating anechoic areas in the collecting system (P) is seen. A dilated proximal ureter (U) is also demonstrated. C—grade 3 hydronephrosis—massive dilation of the collecting system (H) is seen. Note significant thinning of renal cortex (RC) in this patient with long-standing hydronephrosis.

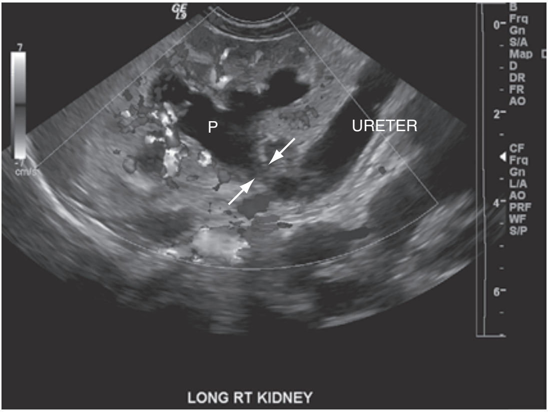


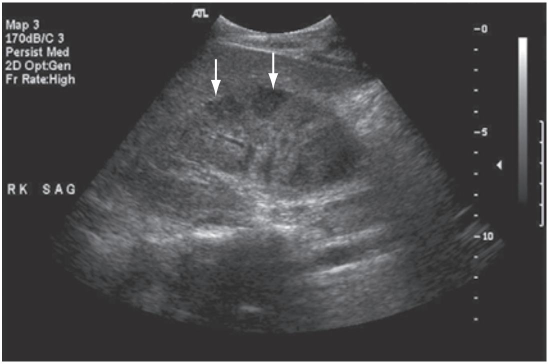
Figure 6-26 Hydronephrosis with hydroureter. Longitudinal sonogram showing dilated renal pelvis (P) and dilated tortuous proximal and mid ureter. Echoes arising from scanning artifacts (arrows) are seen due to tortuosity of the ureter (see color inserts).

Renal Tuberculosis

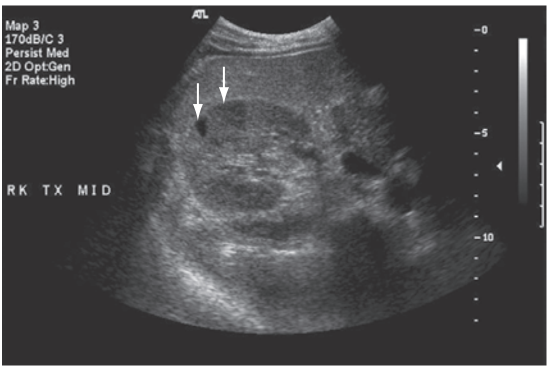
- Seen as cortical masses of variable echogenicity
- Masses may be hypoechoic, echogenic or mixed (Figure 6-29A and B).
- Chronic infection may result in perinephric abscess and eventually small calcified kidney.

Medical Renal Disease

- Acute
  - Enlarged kidneys with echogenic cortex (Figure 6-30A)
  - Prominent medullary pyramids
- Chronic
  - Small kidneys
  - Echogenic cortex (isoechoic to sinus) (Figure 6-30B)



(A)



(B)

Figure 6-27A & B Acute pyelonephritis. Longitudinal and transverse images demonstrate hypoechoic and anechoic masses (arrows) on the renal cortex in a patient with acute pyelonephritis. These may represent focal abscesses.

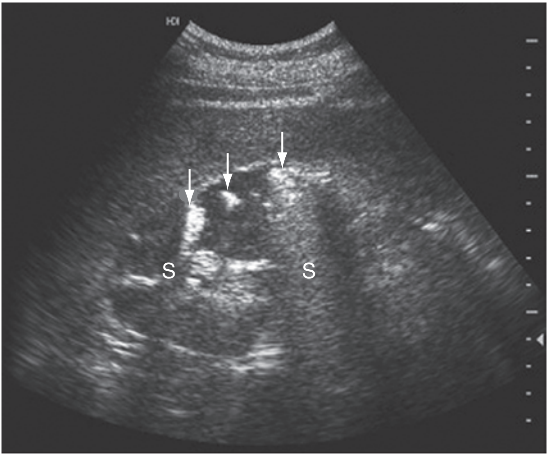


Figure 6-28 **Emphysematous pyelonephritis.** Hyperechoic areas (arrows) with dirty shadows (s) are seen. This represents intrarenal gas.

Source: Courtesy of Mosby, reprinted with permission.

The Urinary Bladder

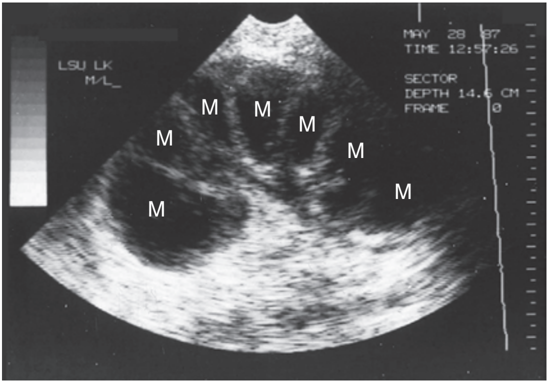
Normal Sonographic Anatomy

- Anechoic with thin walls when fully distended (Figure 6-31)
- Hyperechoic thick walls (greater than 3 mm) when partially distended
- Ureteral jets seen as flashing echoes within urinary bladder (Figure 6-32)
- Presence of jets indicates that ureter is not obstructed.

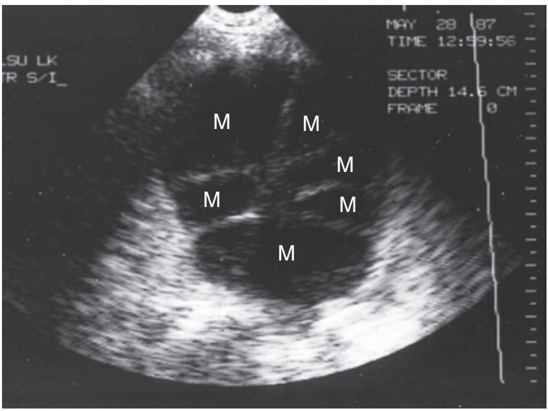
Bladder Pathology

Calculi

- Echogenic focus within bladder (Figure 6-33)
- Posterior acoustic shadowing
- Gravity dependent motion if not embedded

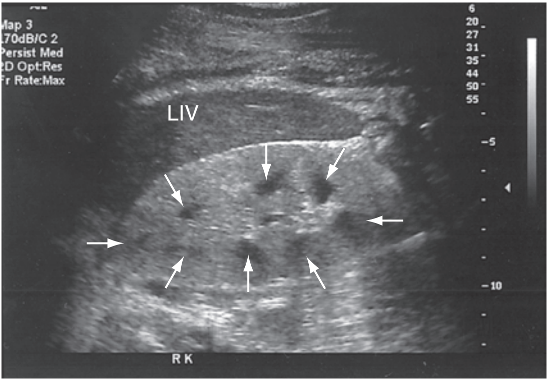


(A)

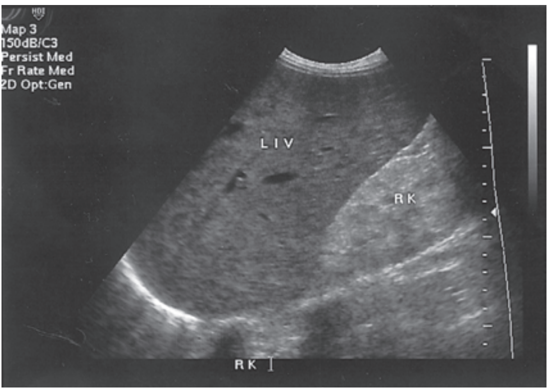


(B)

Figure 6-29A & B Renal tuberculosis. Longitudinal (A) and transverse (B) images of the left kidney in a patient with renal tuberculosis demonstrate multiple anechoic to hypoechoic masses (M) replacing the renal parenchyma. These masses may represent dilated renal calyces. The contralateral kidney was normal in appearance.



(A)



(B)

Figure 6-30A & B Acute and chronic medical renal disease. In (A), the kidney is enlarged and echogenic with prominent pyramids (arrows). In (B) the kidney is small and echogenic. The renal sinus is not distinguishable from the cortex. In both examples, the kidneys are more echogenic than the adjacent normal liver (LIV) parenchyma.

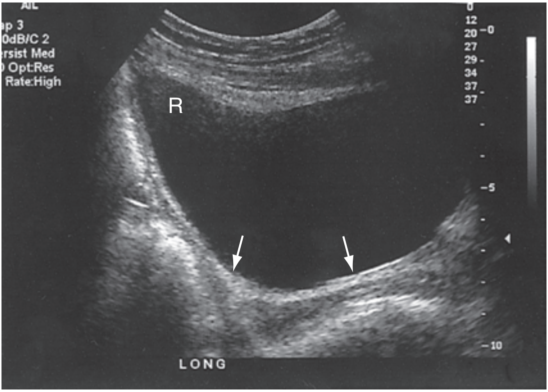


Figure 6-31 Normal urinary bladder. A sagittal sonogram of the normal distended bladder demonstrates thin walls (arrows) with low-level echoes on its anterior wall which represent reverberation artifact (R).

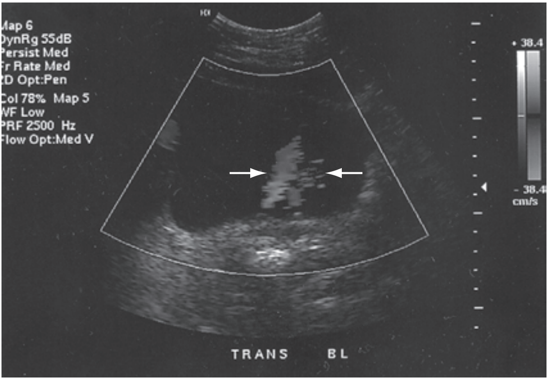


Figure 6-32 Ureteral jets. Color Doppler demonstrates ureteral jets (arrows) within the bladder indicating nonobstruction of the ureters (see color inserts).

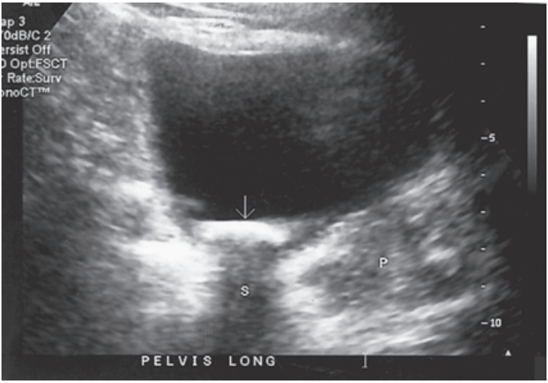


Figure 6-33 **Bladder calculus.** A longitudinal sonogram shows hyperechoic calculus (arrow) with acoustic shadowing (S) within the bladder. The prostate (P) is seen inferior to the bladder.

Benign and Malignant Tumors

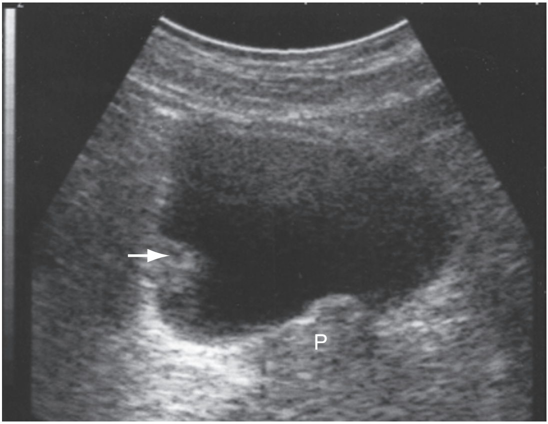
- Focal or diffuse bladder wall thickening
- Echogenic, nonmobile mass with or without shadowing (Figure 6-34A and B)
- Enlarged prostate may mimic bladder tumor (Figure 6-35).

Hematomas

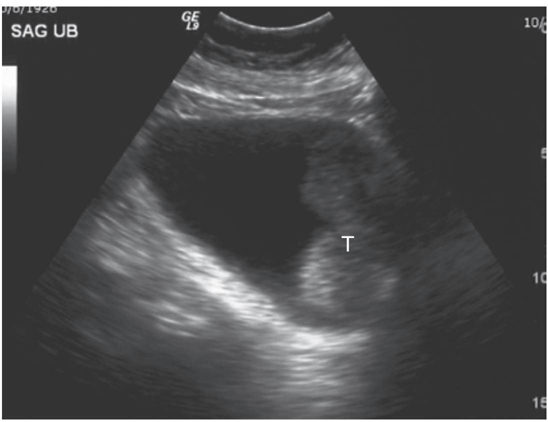
- Echogenic or complex mass within bladder (Figure 6-36)
- May fill bladder completely
- Above may mimic tumor.
- Small hematomas can be mobile with change in patient position.

Bladder Diverticulum

- Anechoic fluid-filled structure adjacent to bladder



(A)



(B)

Figure 6-34A & B Malignant bladder tumor. In (A), a transverse sonogram demonstrates echogenic malignant tumor (arrow) in bladder wall of a male patient. The prostate gland (P) is seen posteriorly. In (B), a larger malignant tumor (T) is seen extending from anterior to posterior within the bladder.

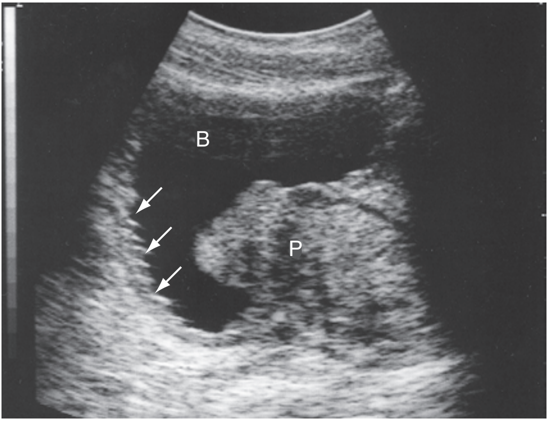


Figure 6-35 Enlarged prostate mimicking bladder tumor. A longitudinal sonogram shows an enlarged heterogeneous prostate (P) indenting the urinary bladder (B). This appearance can mimic a bladder mass. Thickened and trabeculated bladder wall (arrows) due to benign prostatic hyperplasia is also apparent.

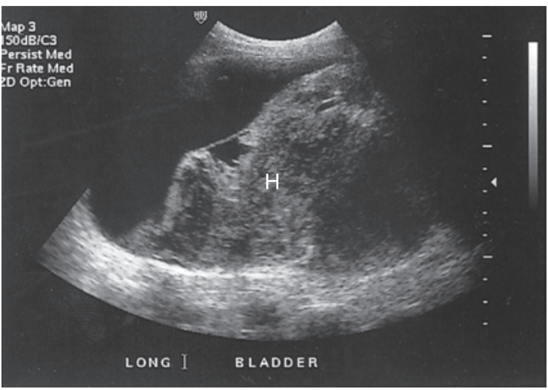


Figure 6-36 Bladder hematoma. A longitudinal sonogram in a patient with gross hematuria demonstrates a large hematoma seen as a complex mass (H) within the bladder. The hematoma almost completely fills the urinary bladder.

- Connection to bladder (neck) seen in most cases
- May contain echoes with shadow (stones) or low-level echoes representing thrombus or tumor (Figure 6-37A and B)
- Can mimic cystic pelvic mass when fluid filled and neck not visualized
- Diverticulum not visualized on postvoid images of bladder

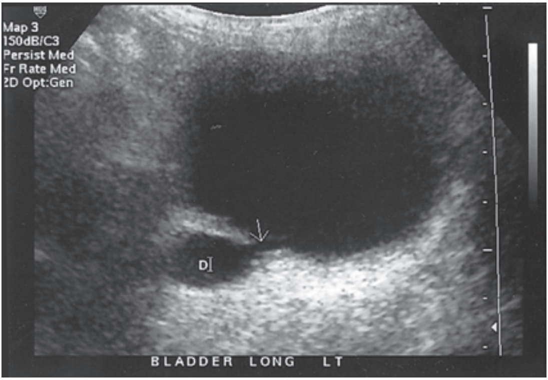
Ureterocele

- Round or oval cystic structure at ureteral orifice (Figure 6-38)
- May cause hydronephrosis
- Can vary in size as they fill and empty with urine

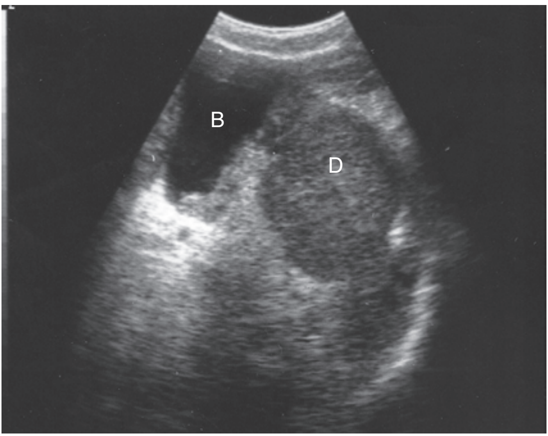
Urinary retention

- Results in a significantly distended urinary bladder that may extend into the upper abdomen (Figure 6-39)
- Bladder walls may be thin or thickened (greater than 3 mm).
- Thickened bladder wall may also be seen in patients with cystitis and long-term benign prostatic hyperplasia (Figure 6-40).
- Distended bladder may mimic large, cystic pelvic mass.
- Bladder volume estimation can be performed by measuring width, length, and height (Figure 6-41).

Calculations can be performed by machine or by hand using one of several formulas (e.g., bladder volume = 0.75 x width x length x height)



(A)



(B)

Figure 6-37A & B Bladder diverticulum. In (A), a longitudinal sonogram demonstrates a bladder diverticulum (D) originating from the posterior wall of the urinary bladder (B). A narrow neck (arrow) is seen. In (B), a large diverticulum (D) in a different patient has low-level echoes caused by thrombus. The neck is not visualized. This appearance can also mimic a tumor within the diverticulum or a pelvic mass. B—urinary bladder.

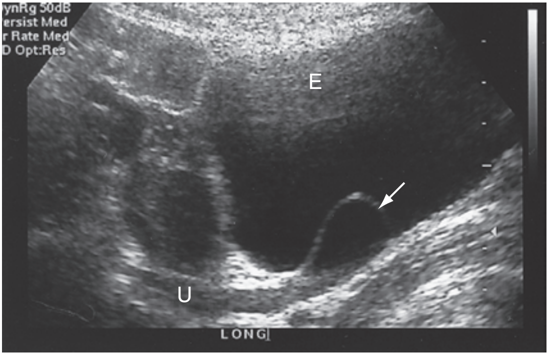


Figure 6-38 Ureterocele. A longitudinal sonogram demonstrates a ureterocele (arrow) within the urinary bladder. The ureter (U) and anterior bladder contain low-level echoes (E) caused by high gain setting.

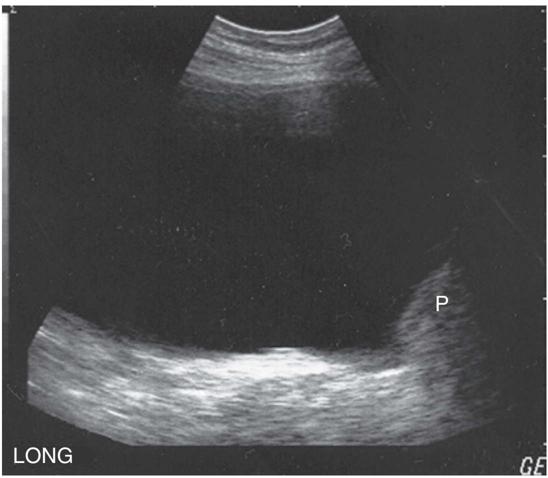


Figure 6-39 Urinary retention. A longitudinal image of the urinary bladder in a patient with urinary retention shows significant distention. Note that the superior border of the bladder is beyond the field of view of this sector probe and therefore is not imaged on this section. The prostate gland (P) is seen inferior to the bladder.

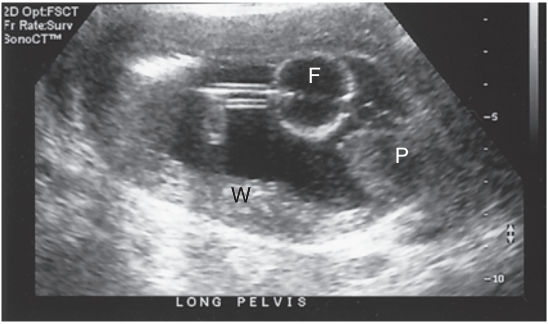


Figure 6-40 Bladder wall thickening. A longitudinal image demonstrates diffuse thickening (W) of the bladder wall in a patient with long-standing obstructive benign prostatic hyperplasia. F—foley catheter, P—prostate gland.

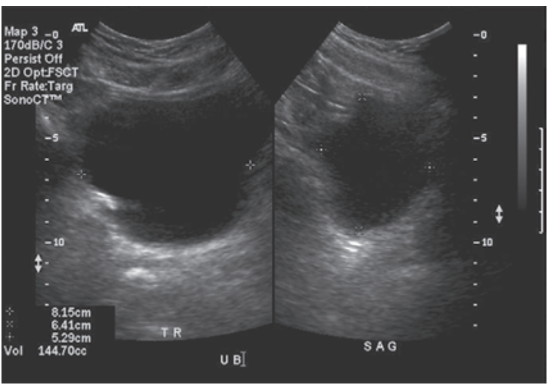


Figure 6-41 Calculation of post-void bladder residual volume. Automated calculations are performed by machine from width, length, and height of bladder. In this example, the postvoid residual volume was 144.70 cc.

Chapter 7: The Gastrointestinal System

DUNSTAN ABRAHAM

Normal Bowel

- Seen as bull's-eye configuration on cross-section
- Above consist of the following:
  - Inner lumen—anechoic when fluid filled, echogenic with or without shadowing when filled with gas or fecal material
  - Outer wall—hypoechoic (Figure 7-1)
- High-resolution transducers may demonstrate bowel's multiple layers that appear alternatively echogenic and hypoechoic
- Bowel wall normally measures up to 3 mm distended and up to 5 mm nondistended

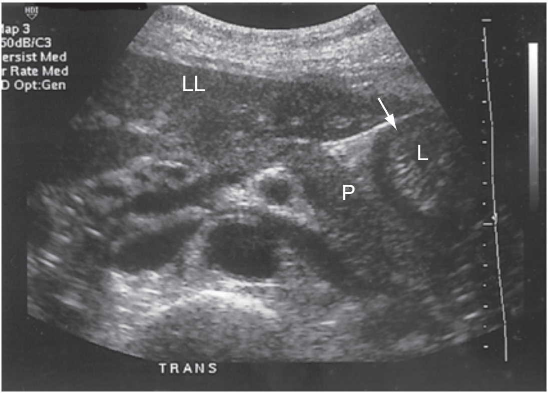


Figure 7-1 Normal stomach. A transverse view showing normal stomach in cross-section. The echogenic inner lumen (L) is surrounded by the hypoechoic outer wall (arrow). P—tail of pancreas, LL—left lobe of the liver.

- Normal bowel demonstrates the following characteristics during scanning:
  - Peristalsis
  - Changes in size and shape
  - Compressibility
- Bowel can mimic masses and free fluid.

Normal Appendix

- Occasionally seen on ultrasound
- Tubular and hypoechoic when visualized (Figure 7-2)

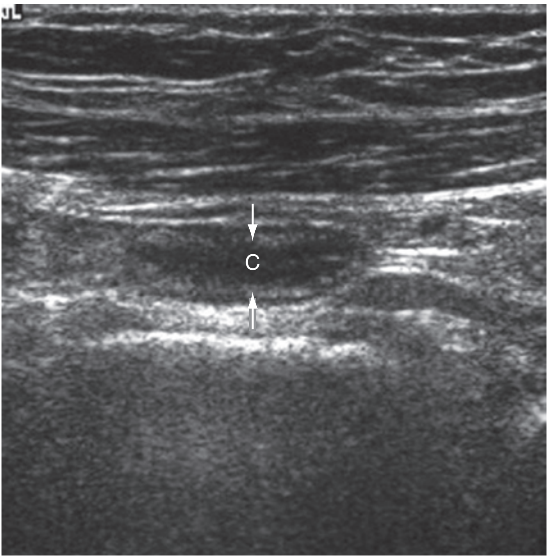


Figure 7-2 Normal appendix. A longitudinal view of the normal appendix in a 9-year-old girl demonstrates a tubular structure with hypoechoic center (c) and echogenic walls (arrows).

Source: Courtesy of Mosby, reprinted with permission.

- Peristalsis and compressibility present
- Wall thickness measures up to 2 mm
- Outer diameter measures up to 6 mm

Pathology

Appendicitis

- Appendix wall measures greater than 2 mm (Figure 7-3).
- Outer diameter measures greater than 6 mm.
- Absence of peristalsis and compressibility
- Intraluminal echoes with shadow represent calculi (Figure 7-4).
- Increased color Doppler flow may be present.
- Abscess resulting from perforation seen as loculated fluid or complex mass (Figure 7-5)

Intussusception

- Alternating hypoechoic and hyperechoic rings surrounding an echogenic center (Figure 7-6)

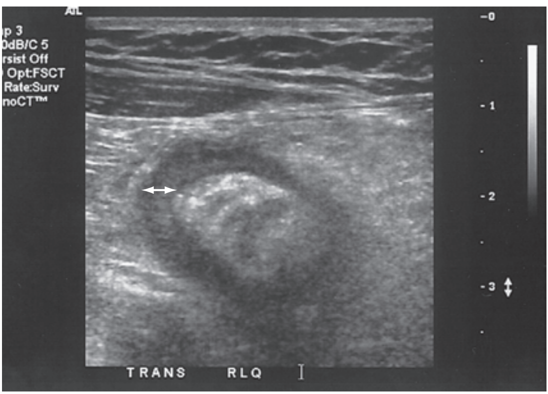


Figure 7-3 Appendicitis. A transverse view of inflamed appendix shows thickened walls (between arrows). There was also lack of compressibility with transducer pressure.

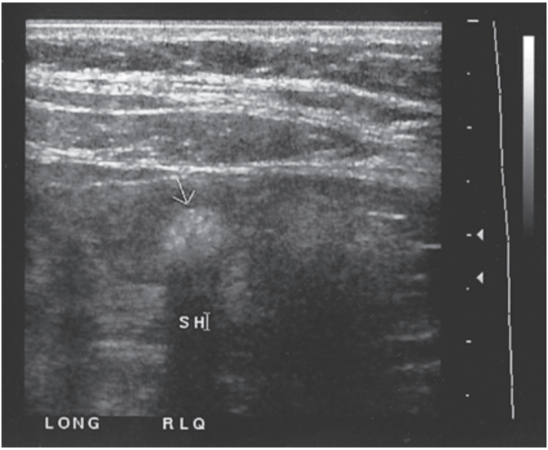


Figure 7-4 Appendicitis with fecalith. A transverse section showing an appendix with fecalith (arrow) and posterior acoustic shadowing (SH).

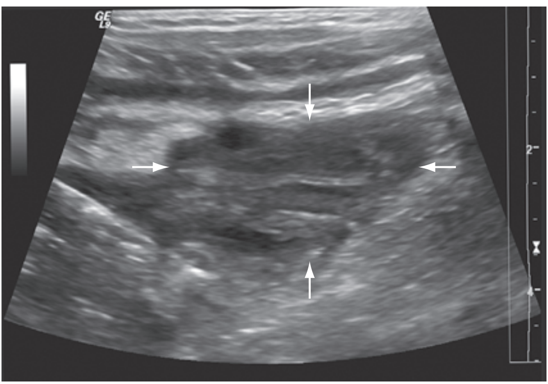


Figure 7-5 Appendiceal abscess. A transverse view of the right lower quadrant shows a complex mass (between arrows) consistent with appendiceal abscess.

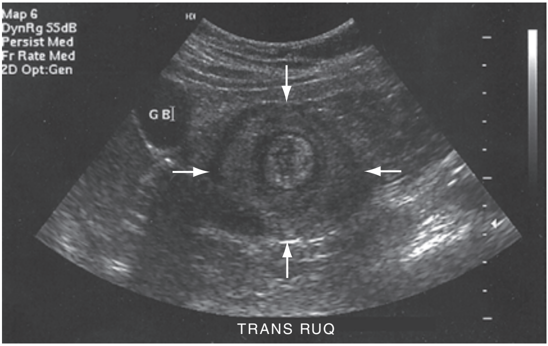


Figure 7-6 Intussusception. A transverse section of affected bowel loops (between arrows) demonstrates an echogenic center with alternating rings that are hypoechoic and hyperechoic.

- Above known as target sign or donut sign
- Free fluid seen on occasions
- Bowel tumors and inflammatory bowel diseases may mimic intussusception (discussed later in this section).

Inflammatory Bowel

- May present as thickened bowel (Figure 7-7)

Benign and Malignant Tumors

- Bowel thickened in early stage
- Solid or complex mass seen in advanced disease (Figure 7-8)

Mechanical Bowel Obstruction

- Multiple, small dilated bowel loops
- Long loops of dilated bowel (Figure 7-9)
- Anechoic fluid or echogenic gas with shadowing seen within bowel segments
- Peristalsis initially increased, later decreased, or absent

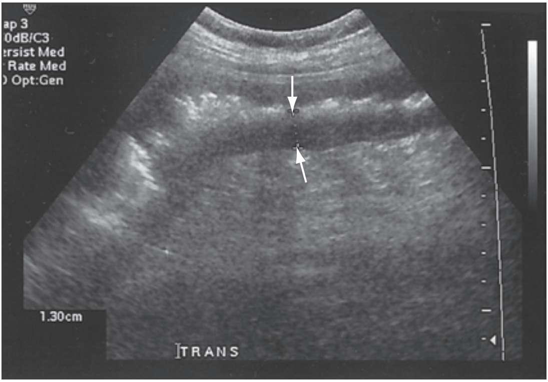


Figure 7-7 Inflammatory bowel. Transverse image of bowel segment taken at mid abdomen in a patient with Crohn's disease. Thickening of the bowel loops (between arrows) is demonstrated. Hyperechoic areas within bowel represent air.

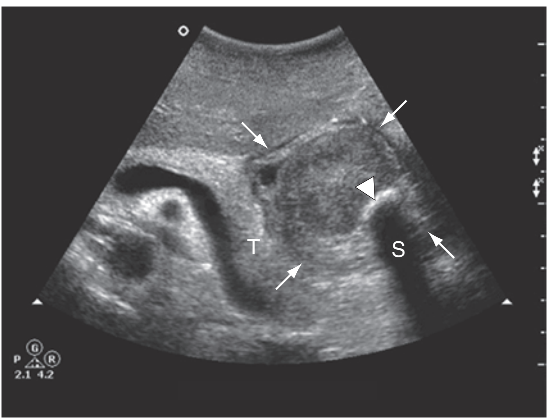


Figure 7-8 Stomach leiomyoma. Transverse image demonstrates a benign stomach tumor (between arrows) that is complex and contains a calcification (arrowhead) with shadowing (S). Note its close proximity to the tail of pancreas (T).

Source: Courtesy of Phillips, reprinted with permission.

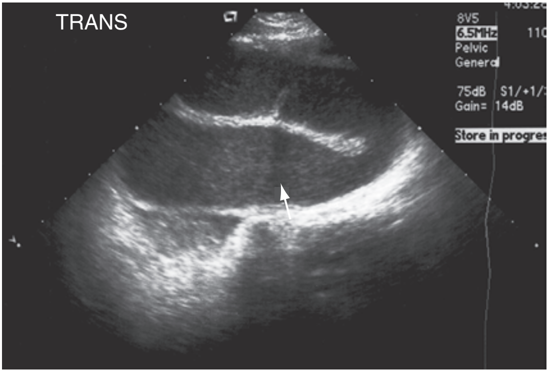


Figure 7-9 Mechanical small bowel obstruction. A transverse image shows a dilated loop of bowel that is fluid filled and contains low level echoes (arrow). Peristalsis was not observed during the exam.

Chapter 8: The Spleen and Lymph Nodes

DUNSTAN ABRAHAM

Normal Sonography of the Spleen

- Homogeneous mid-level echogenicity (Figure 8-1)
- Measures 12 cm x 7 cm x 4 cm
- Echogenic diaphragm seen posteriorly, superiorly, and laterally
- Accessory spleen may be seen as small isoechoic structure adjacent to spleen (Figure 8-2).

Splenic Pathology

Splenomegaly

- Spleen measures greater than 12 cm in length (Figure 8-3).

Atrophy

- Small or nonvisualized spleen
- Commonly seen in late sickle cell disease

Splenic Cyst

- Anechoic, smooth-walled mass, with increased transmission
- Small cyst seen within splenic parenchyma (Figure 8-4)
- Larger cyst, such as epidermoid cyst, may become exophytic (Figure 8-5).
- May have low-level echoes caused by hemorrhage or infection
- May have echogenic calcification with posterior shadowing

Hemangioma

- Well-defined mass varying from hyperechoic to complex (Figure 8-6)

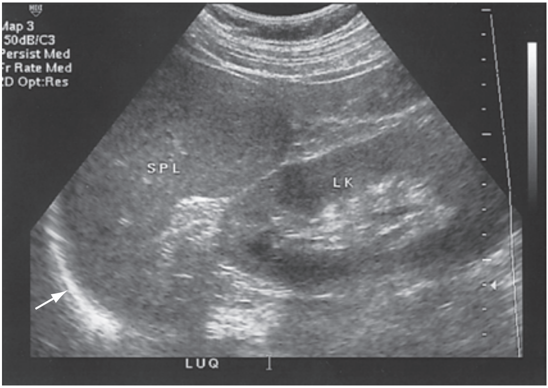


Figure 8-1 Normal spleen. A longitudinal image demonstrates the normal spleen (SPL) with homogeneous midlevel echoes bordered by the diaphragm (arrow) superiorly. LK—left kidney.

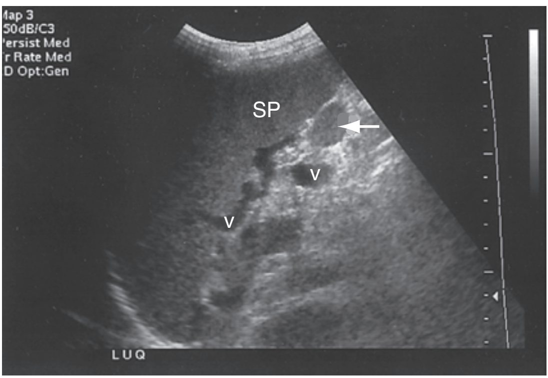


Figure 8-2 Accessory spleen. A longitudinal image of the left upper quadrant demonstrates an accessory spleen (arrow) adjacent to the splenic border (SP). The accessory spleen is isoechoic to the normal spleen. Anechoic structure represents normal vessels (V).

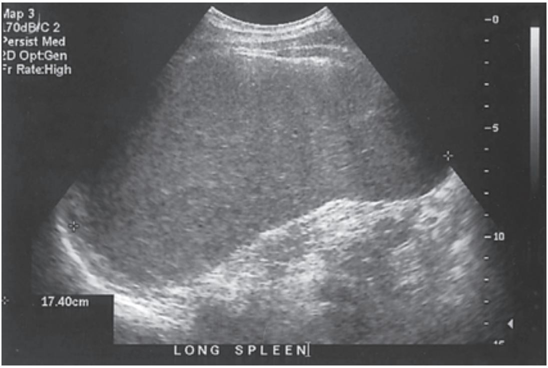


Figure 8-3 Splenomegaly. Longitudinal image of an enlarged spleen that measures 17.4 cm from superior to inferior. The splenic texture is homogeneous and moderately echogenic.

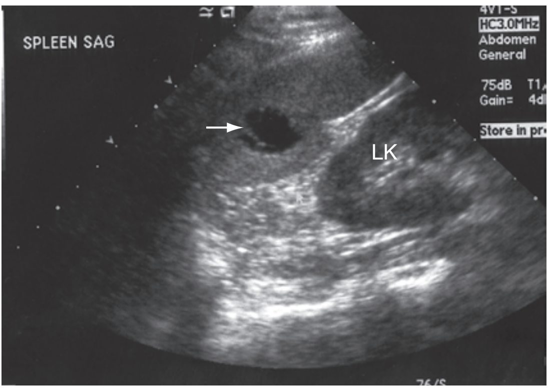


Figure 8-4 Splenic cyst. Sagittal image demonstrates an anechoic cyst within the spleen. It contains a hyperechoic septation (arrow) and demonstrates posterior acoustic enhancement. LK—left kidney.

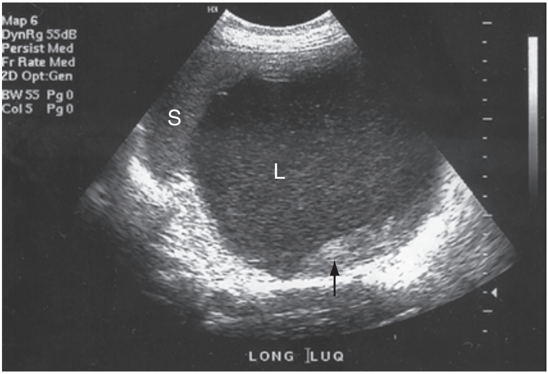


Figure 8-5 Epidermoid cysts. A sagittal sonogram shows large splenic cyst with diffuse low-level echoes (L) and some high-level echoes (arrow) on the posterior border. These echoes may be due to hemorrhage or infection. The cyst extends outside the borders of the splenic parenchyma. A small section of the spleen (S) is seen superiorly.

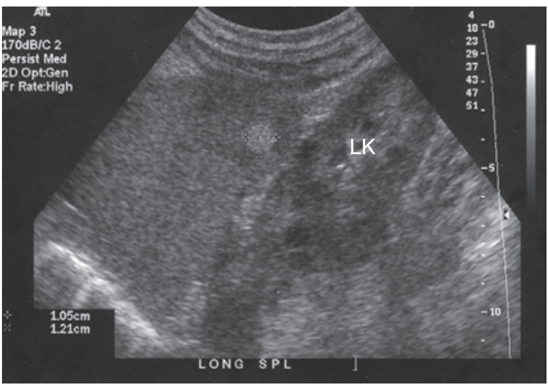


Figure 8-6 Splenic hemangioma. Longitudinal sonogram of spleen with hemangioma (between calipers) seen as a well-defined hyperechoic mass. LK—left kidney.

- May also contain echogenic calcification with posterior shadowing

Abscess

- Variable appearance
- Complex appearance most common (Figure 8-7)
- Poorly or well-defined walls
- Increased or decreased enhancement
- Hyperechoic foci within mass may represent debris or gas.
- Above pattern may mimic infarction, neoplasm, or hematoma.
- Fluid-filled stomach may mimic splenic abscess (Figure 8-8).
- Look for peristalsis and location outside of splenic margins.

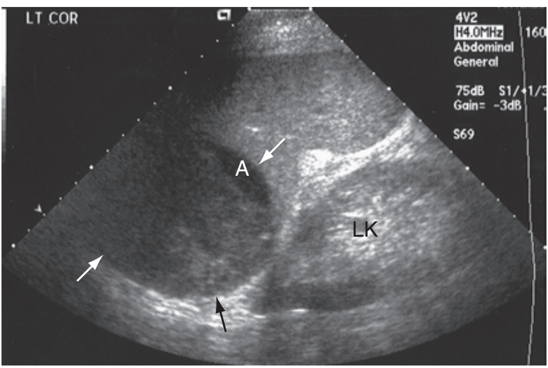


Figure 8-7 Splenic abscess. A sagittal image of the spleen with abscess (between arrows) seen as a predominantly solid mass with smooth borders. A small peripheral anechoic fluid area (A) is visualized. LK—left kidney.

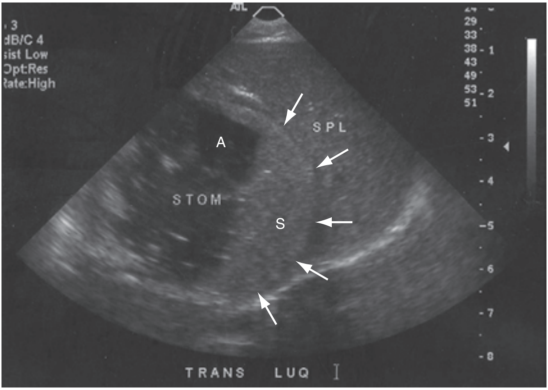


Figure 8-8 Stomach mimicking splenic abscess. Transverse view of the left upper quadrant demonstrates the stomach (STOM) with both fluid (A) and solid areas (S). This appearance can be mistaken for a mass such as an abscess; however, note the thin line of demarcation (arrows) between the stomach and spleen (SPL).

Splenic Calcifications

- Seen as multiple, diffuse hyperechoic foci in granulomatous diseases such as tuberculosis (Figure 8-9)
- Calcifications linear and echogenic when seen within splenic artery
- Circular in shape when seen surrounding wall of cyst
- Calcifications may demonstrate shadowing.

Infarction

- Hypoechoic lesion in early stage (Figure 8-10) and hyperechoic in late stage
- May be peripheral in location and wedge shaped
- Base of wedge located on splenic capsule

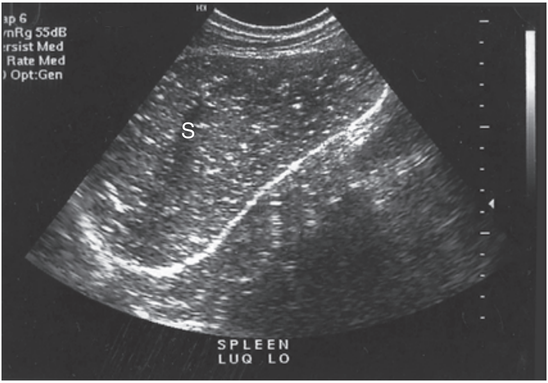


Figure 8-9 **Splenic granulomas.** Multiple diffuse echogenicities representing granulomas are seen in this patient with tuberculosis. Shadowing (s) is associated with some of the granulomas.

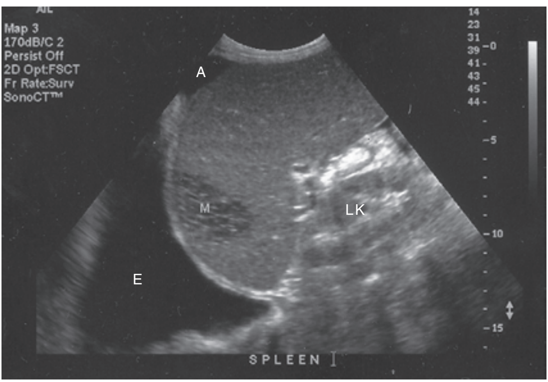


Figure 8-10 **Splenic infarction.** A sagittal image demonstrates a wedge-shaped hypoechoic lesion (M) representing infarction. LK—left kidney, E—pleural effusion, A—ascites.

Candidiasis

- Bull's-eye appearance seen as hypoechoic rim with an echogenic center (Figure 8-11)
- Mass may also appear hypoechoic or hyperechoic.

Malignant Tumors

Lymphoma

- Multiple hypoechoic masses
- Diffusely inhomogeneous spleen
- Enlarged lymph nodes seen (see lymphadenopathy later in this section)

Metastasis

- Variable appearance
- Hypoechoic to hyperechoic mass(es) (Figure 8-12)

Splenic Trauma

- See Chapter 9—Abdominal Trauma

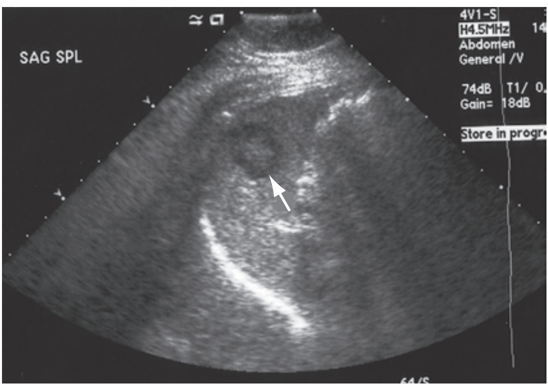


Figure 8-11 Splenic candidiasis. Bull's-eye–appearing mass (arrow) in the spleen caused by candidiasis.

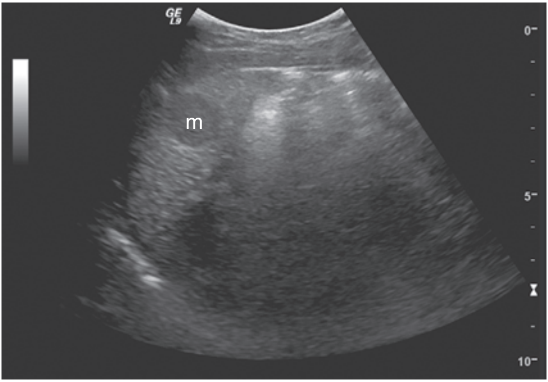


Figure 8-12 **Splenic metastasis.** A longitudinal image demonstrates splenic metastasis seen as a well-defined, hypoechoic mass (m) in a patient with leukemia.

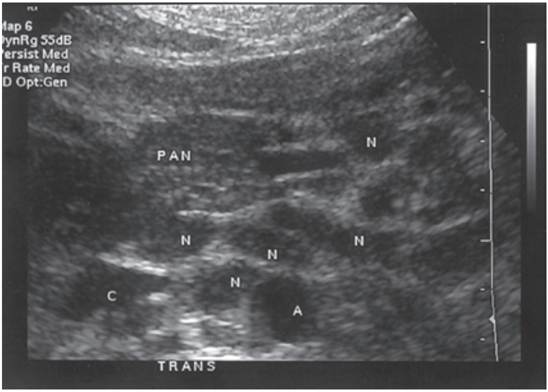
Lymph nodes

Normal lymph nodes

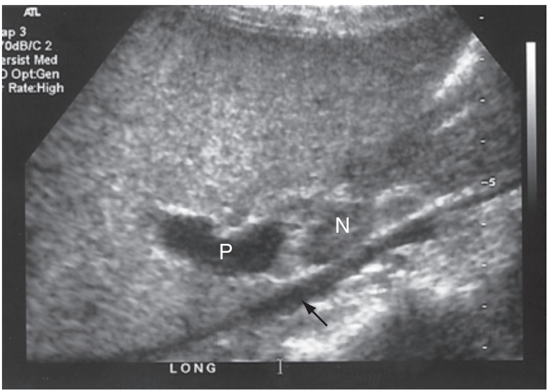
- Retroperitoneal nodes measure less than 1 cm.
- Not visualized routinely in abdominal scanning

Lymphadenopathy

- Round- or oval-shaped masses
- Hypoechoic or anechoic
- Measure greater than 1 cm in size
- Usually seen anterior and posterior to aorta and inferior vena cava, peripancreatic (Figure 8-13A), porta hepatis (Figure 8-13B), and hilum of spleen and in pelvis adjacent to the iliac vessels
- Nodes may fuse to form mantle of tissue around vessels (Figure 8-14A and B).
- Anechoic or hypoechoic bowel loops may mimic lymphadenopathy.

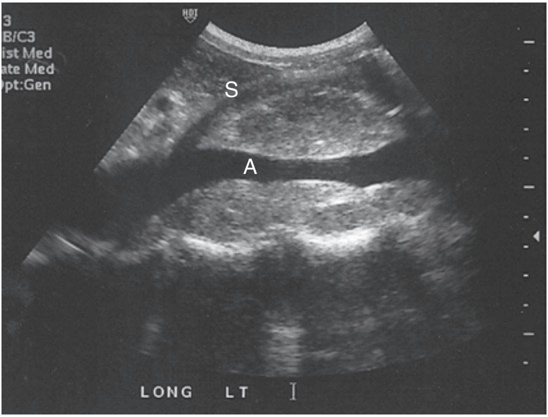


(A)

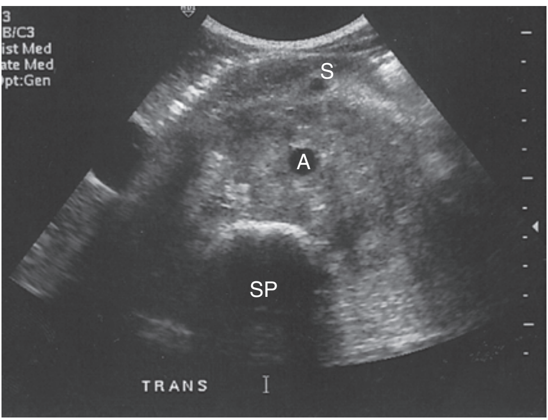


(B)

Figure 8-13A & B Lymphadenopathy. In (A), enlarged lymph nodes (N) are seen near the pancreas (PAN), around the aorta (A), and the inferior vena cava (C). In (B) a single enlarged node (N) is seen in the porta hepatis of the liver. The inferior vena cava (arrow) is seen posterior to the lymph node. P—portal vein.



(A)



(B)

Figure 8-14A & B Lymphadenopathy forming mantle. In longitudinal (A) and transverse (B), the aorta (A) is surrounded by a hypoechoic mantle of tissue. Also seen is the anterior displacement of the superior mesenteric artery (S). SP—shadowing from spine.

Chapter 9: Blunt Abdominal Trauma

DUNSTAN ABRAHAM

Blunt abdominal trauma may commonly involve the spleen, kidneys, and liver. Complications after trauma to these organs can be frequently seen on sonography.

Complications of Blunt Abdominal Trauma Seen on Sonography

- Diffuse organ injury
- Hematomas
- Hemoperitoneum

Sonographic Findings in Blunt Abdominal Trauma

Diffuse Organ Injury

- Heterogeneous organ parenchyma may indicate splenic rupture (Figure 9-1).
- Abnormal color flow pattern within organs may be seen with injury to vessels.

Hematomas

- Sonographic appearance may change with time.
- Varies from anechoic to echogenic with clot formation and liquefaction
- Variable degree of posterior enhancement

Common Locations of Hematomas

- Intraparenchymal—seen within spleen or liver (Figures 9-2A and B and 9-3)
- Perihepatic and perisplenic—echogenic perisplenic hematomas may mimic splenomegaly
- Subcapsular—seen under capsule of liver or spleen (Figure 9-4)
- Perinephric and pararenal spaces—small hematomas seen around kidneys while large

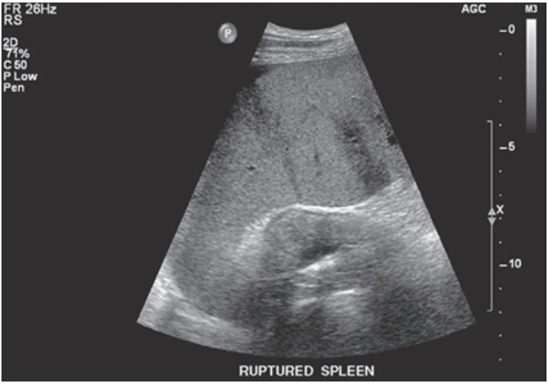


Figure 9-1 Splenic rupture. A longitudinal image shows heterogeneous splenic parenchyma with anechoic areas.

Source: Courtesy of Phillips, reprinted with permission.

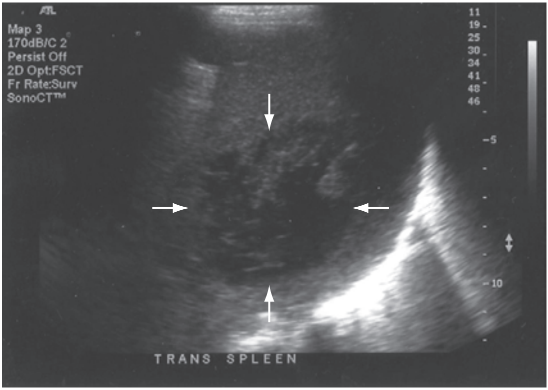
collections may obscure visualization of the organ (Figures 9-5, 9-6A and B, 9-7, 9-8)
- Pelvis—may mimic gynecological mass

Hemoperitoneum

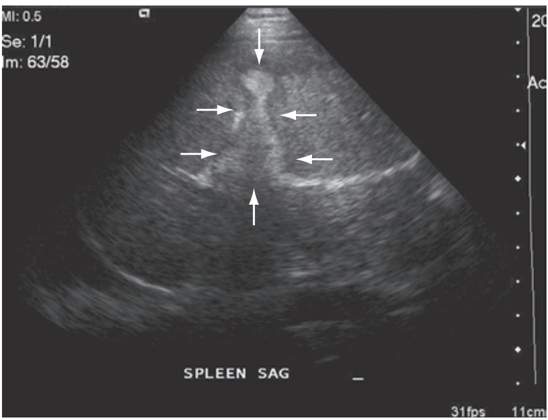
- Seen as anechoic free fluid that may have sharp borders
- Fluid may also have low-level echoes.
- Fluid-filled bowel loops and prominent splenic varices may mimic free fluid (Figure 9-9A and B).

Focused Assessment with Sonography for Trauma (FAST Scan)

- Performed for rapid identification of hemoperitoneum or pericardial fluid
- Specific areas to examine for fluid:
  - Perihepatic (Figure 9-10)
  - Morrison's pouch (hepatorenal space) (Figure 9-10)



(A)



(B)

Figure 9-2A & B Intrasplenic hematomas. In (A), fresh hematoma is seen as a large anechoic mass (between arrows) with minimal low-level echoes in a patient who sustained blunt trauma. In (B), old hematoma is represented by a heterogeneous area that is both echogenic and hyperechoic. This patient was scanned 3 weeks after splenic injury due to a fall.

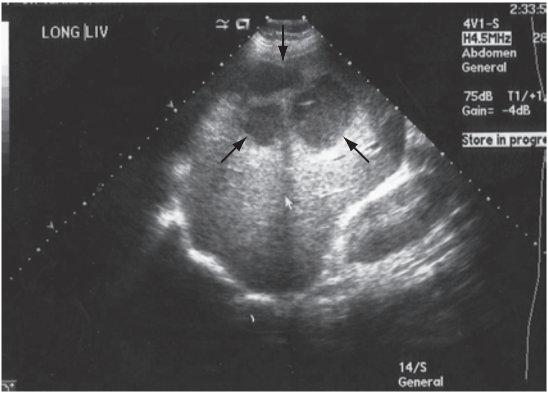


Figure 9-3 Intrahepatic hematoma. The liver contains an anechoic irregular cystic mass (arrows) in the right lobe. There are some low-level echoes with a fair amount of posterior enhancement.

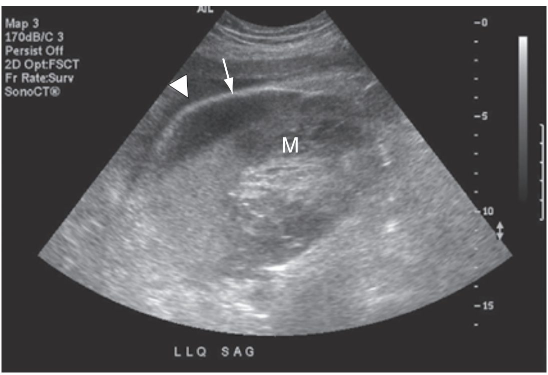


Figure 9-4 Subcapsular hematoma. A longitudinal view shows large complex mass (M) under the curved echogenic splenic capsule (arrow). A small amount of perisplenic fluid (arrow head) is also seen.

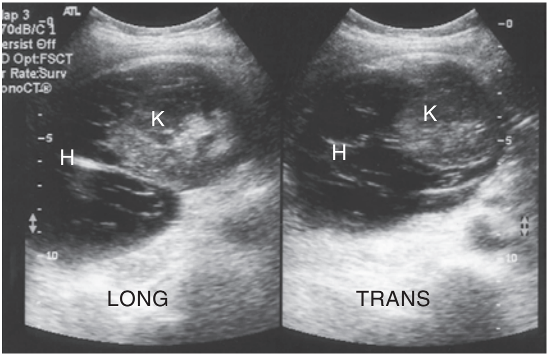


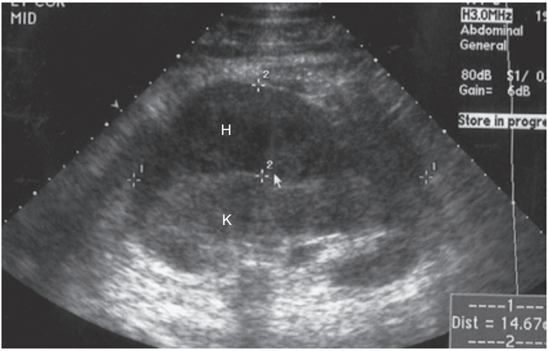
Figure 9-5 Perinephric hematoma. A longitudinal and transverse views demonstrate hematoma (H) around the kidney (K). The collection is anechoic with multiple linear hyperechoic septations.

- Perisplenic (Figure 9-11)
- Paracolic gutters (flanks)
- Pelvis (Figure 9-12)
- Pericardium

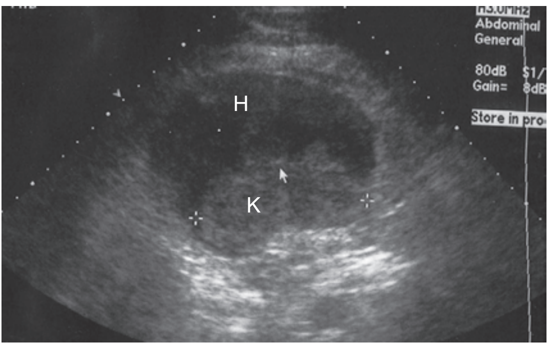
- Volume of fluid (blood) can be quantified by measuring fluid pockets.

Technical Points

- Gravity-dependent fluid will change location if patient is turned.
- Vessels and fluid are both anechoic; use color Doppler to make distinction.
- Fluid-filled bowel can mimic free-fluid; look for peristalsis and changes in size and shape.



(A)



(B)

Figure 9-6A & B Perinephric hematoma. Longitudinal A and transverse B of perinephric hematoma (H) two weeks post trauma. Note a moderate amount of diffuse low-level echoes representing clot formation. K—kidney.

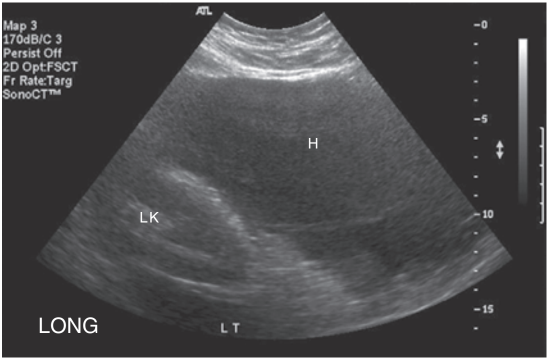


Figure 9-7 Pararenal hematoma. Large anechoic mass (H) with low-level echoes is seen anterior and inferior to the left kidney (LK) in a patient post trauma.

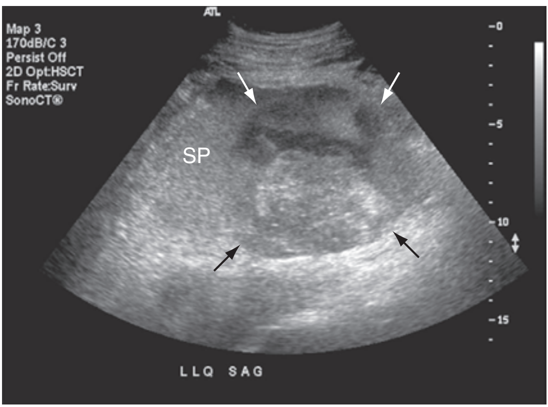
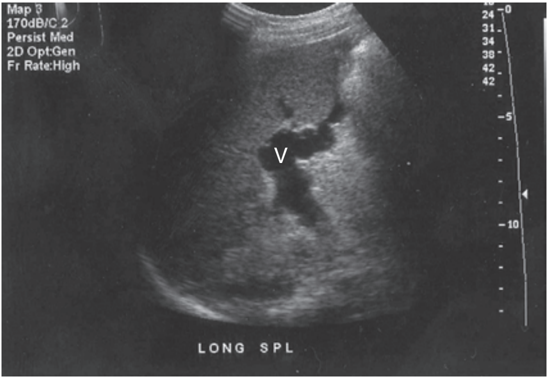
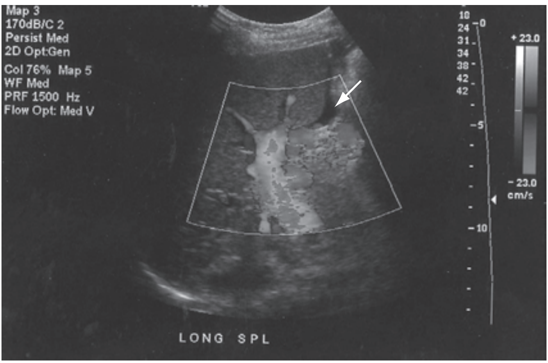


Figure 9-8 Hematoma obscuring kidney. Large hematoma (between arrows) seen in the left renal fossa. The kidney is obscured by the hematoma and therefore not visualized. SP—spleen.



(A)



(B)

Figure 9-9A & B Vessels mimicking fluid. In (A), anechoic vessels (V) around the spleen may mimic free fluid. In (B), color Doppler confirms anechoic structure to be a splenic vessels (see color inserts). However, a small anechoic area (arrow) without Doppler flow is seen under the spleen. This represents a minimal amount of free fluid.

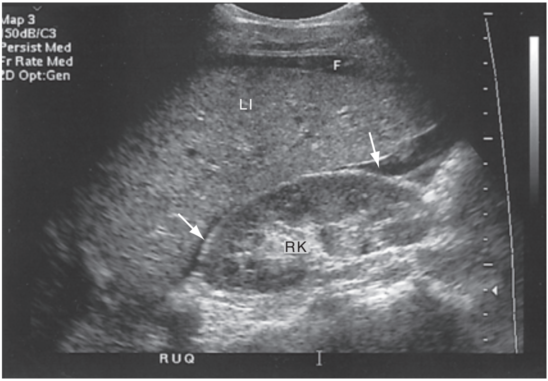


Figure 9-10 Fluid in perihepatic space and Morrison's pouch. Longitudinal view of the right upper quadrant shows fluid (F) around liver (LI) and in Morrison's pouch (arrows). RK—right kidney.

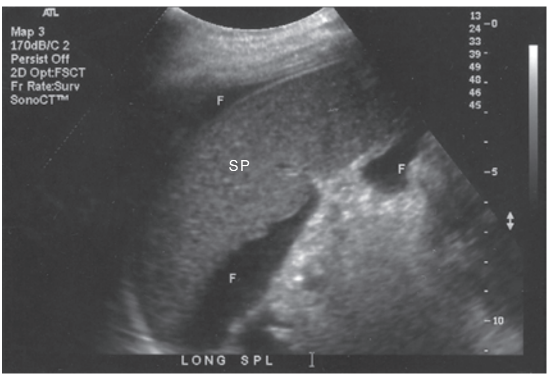


Figure 9-11 Perisplenic fluid. Anechoic fluid (F) is seen surrounding the spleen (SP).

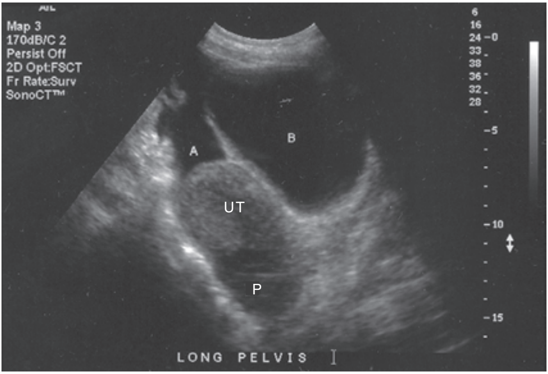


Figure 9-12 Fluid in the pelvis. Anechoic fluid is seen in the anterior cul-de-sac (A) as well as in the posterior cul-de-sac (P). B—urinary bladder, UT—uterus.

Chapter 10: The Scrotum and Testes

DUNSTAN ABRAHAM

Normal Sonography

- Testes are moderately echogenic and homogeneous (Figure 10-1).
- Measure approximately 3–5 cm (length) x 2–3 cm (width) x 3 cm (anterior posterior)
- Mediastinum testis seen as linear echogenic structure extending craniocaudad within organ (Figure 10-2)
- Epididymis divided into head, body, and tail (Figure 10-3)

Head of Epididymis

- Also known as globus major and located superiorly
- Above isoechoic to testis and measures 10–12 mm in diameter

Body and Tail of Epididymis

- Located along anterolateral or posterolateral aspect of testes
- Hypoechoic to testes and measures less than 4 mm in diameter

Appendix Testis

- Seen as small oval structure beneath the head of the epididymis
- Is isoechoic to testis (Figure 10-4)
- Scrotal skin measures up to 3mm in thickness

Vasculature

- Anechoic tubular structure
- Seen within and around testes on color Doppler (Figure 10-5)

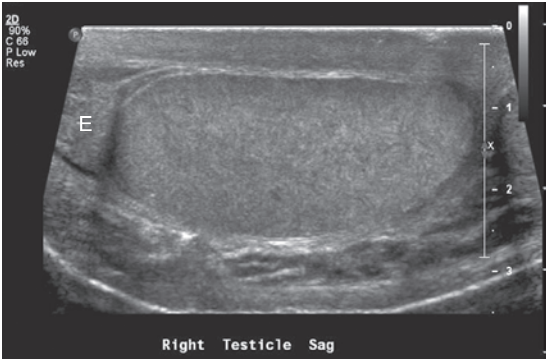


Figure 10-1 Normal testicle. Sagittal view of testis with homogeneous midlevel echoes. E—head of epididymis.

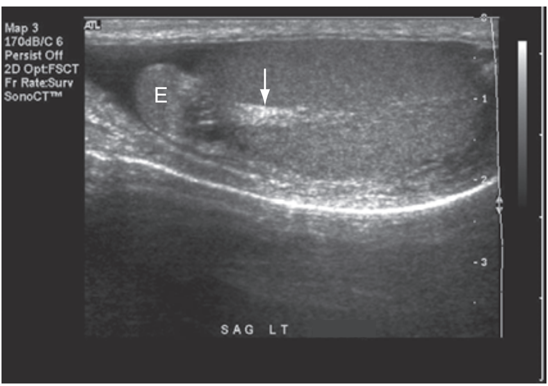


Figure 10-2 Mediastinum testis. Linear echogenic structure (arrow) represents mediastinum testis. E—head of epididymis.

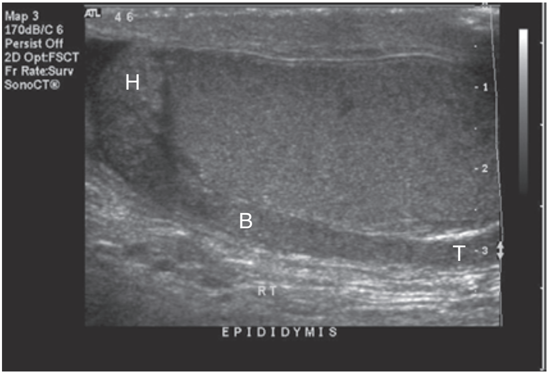


Figure 10-3 Normal epididymis. Normal epididymis is seen superior and posterior to testis. H—head, B—body, T—tail.

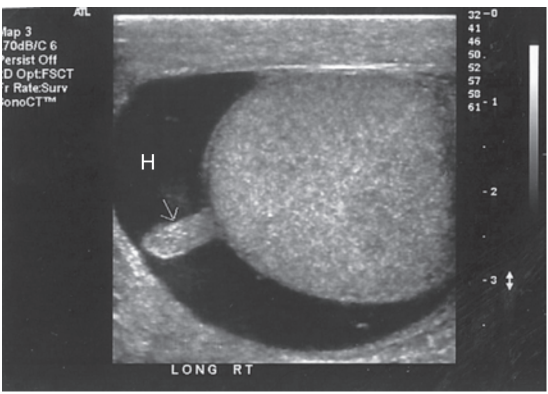


Figure 10-4 Appendix testis. Arrow points to appendix testis, which is isoechoic to normal testis. H—hydrocele.

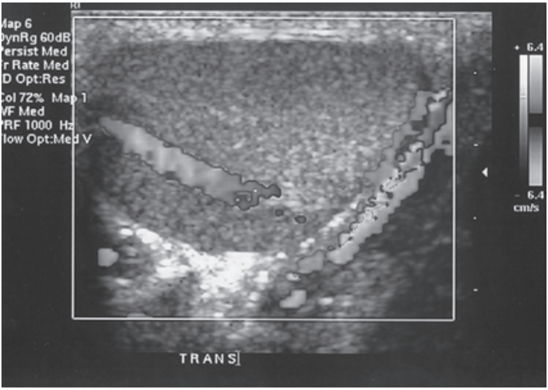


Figure 10-5 Normal testicular vascular flow. Color Doppler shows normal flow both within testicle and on its periphery (see color inserts).

- Centripetal arteries located within testis and travel toward mediastinum
- Capsular arteries located peripherally

Pathology

Acute Testicular Torsion

- Appearance varies with duration of torsion

Torsion Less Than 4 Hours

- Testis has normal echogenicity in most cases
- Intratesticular Doppler flow decreased or absent (color, power, or spectral)

Torsion Greater Than 4 Hours

- Testis is enlarged and heterogeneous (Figure 10-6)
- Intratesticular Doppler flow absent
- Associated findings
  - Scrotal wall thickening
  - Hydrocele (anechoic fluid around testis)

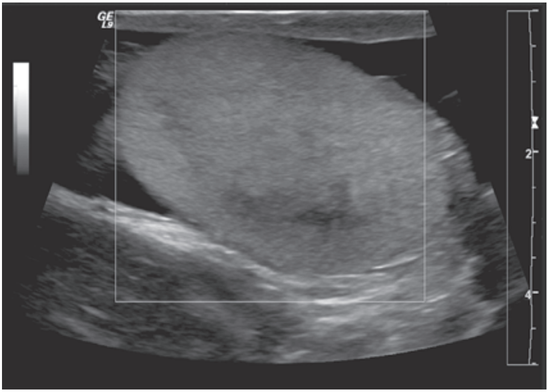


Figure 10-6 **Testicular torsion.** Testis is enlarged and inhomogeneous. No vascular flow is demonstrated on color Doppler.

Partial (Incomplete) Torsion

- Difficult to diagnose
- Intratesticular decreased Doppler flow
- Diminished or reversed diastolic flow on spectral Doppler

Torsion of Appendix Testis

- Measures greater than 5 mm in size
- Absence of Doppler flow in appendix testis
- Increased or decreased echogenicity

Chronic Testicular Torsion

- Testis small and hypoechoic (Figure 10-7)
- Intratesticular Doppler flow absent

Inflammatory Conditions

Epididymitis

- Epididymis enlarged and hypoechoic (Figure 10-8)
- Doppler flow to epididymis is increased.

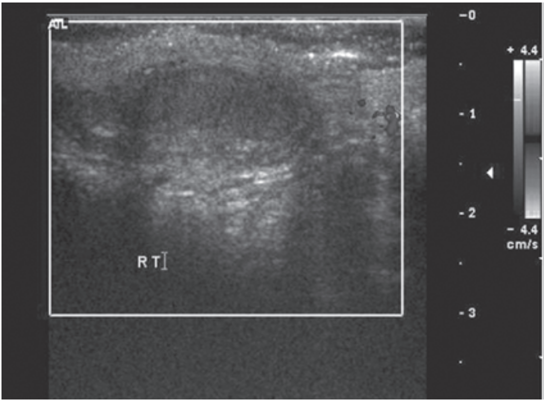


Figure 10-7 Chronic torsion. Testis is small and hypoechoic. There is absence of flow within testicular parenchyma on color Doppler (see color inserts).

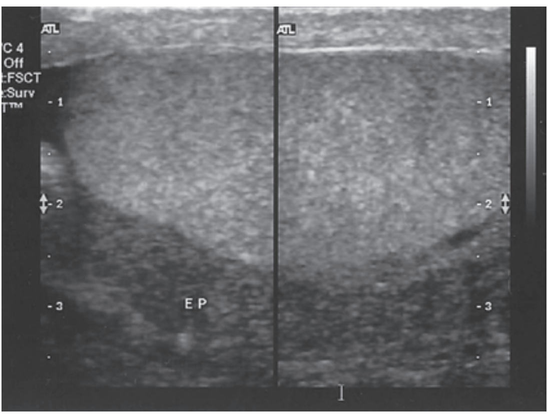


Figure 10-8 Epididymitis. The epididymis (EP) is enlarged and hypoechoic due to inflammation. Note that the testis has normal echogenicity and is not involved in the inflammatory process.

- Associated findings include hydrocele and scrotal skin thickening (greater than 3 mm).

Orchitis

Diffuse Orchitis

- Testis inhomogeneous (Figure 10-9A)
- Intratesticular Doppler flow increased (Figure 10-9B)

Focal Orchitis

- Testis has focal hypoechoic area(s).
- Intratesticular Doppler flow to involved area is increased.
- May mimic tumor

Testicular and Scrotal Abscesses

- May result from epididymo-orchitis
- Testis may be enlarged when involved.
- Testicular abscess seen as intratesticular mass (predominantly fluid filled) (Figure 10-10)
- Scrotal abscess seen as complex mass outside of testis (Figure 10-11)
- Fluid with low-level echoes and septations around testis may represent pyocele (Figure 10-12A and B).
- Increased Doppler flow within abscess

Testicular Trauma

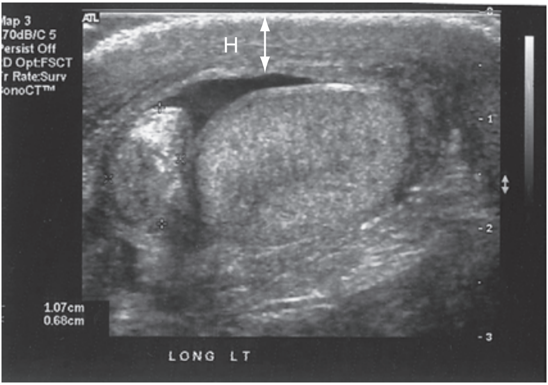
- Can result in hematoma, hematocele, or testicular rupture

Hematoma

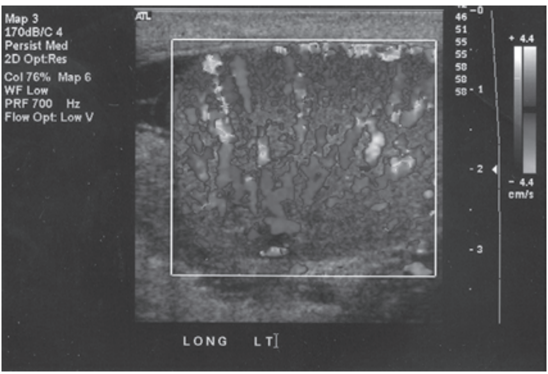
- Intratesticular or extratesticular location
- Anechoic, hyperechoic, or complex in appearance (Figures 10-13 and 10-14A and B)
- Absent Doppler flow within hematoma

Hematocele

- Variable sonographic appearance



(A)



(B)

Figure 10-9A & B Diffuse orchitis. In (A), the testis is inhomogeneous in texture because of diffuse orchitis. Note also that the scrotal skin (between arrows) is thickened and the head of the epididymis (between markers) enlarged. A small hydrocele (H) is also demonstrated. In (B), orchitis in a different patient demonstrates increased Doppler flow (see color inserts).

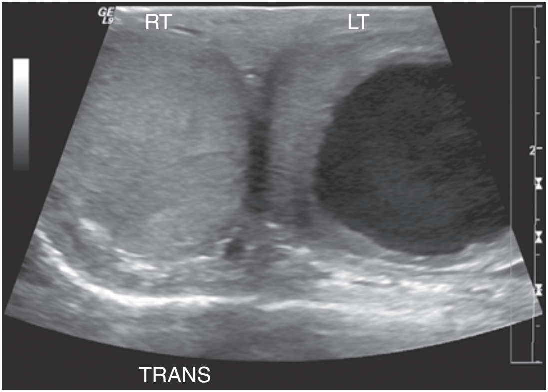


Figure 10-10 Testicular abscess. Transverse view of the testicles demonstrates a large anechoic mass with low-level echoes (abscess) in the left testis (LT). The abscess replaces most of the testicular parenchyma. The adjacent right testicle (RT) is normal.

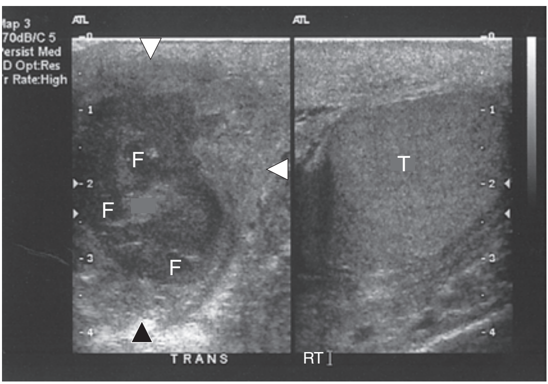
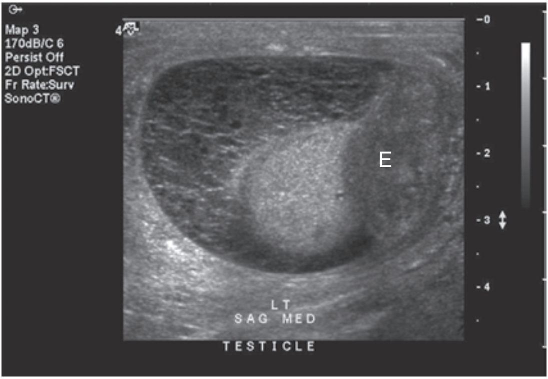
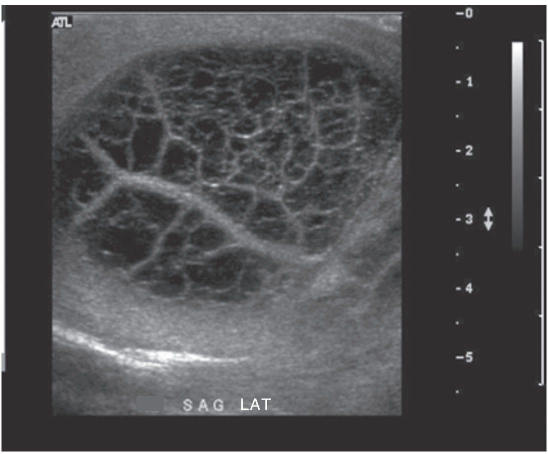


Figure 10-11 Scrotal abscess. Transverse view of the right hemiscrotum partially shows a large complex mass (arrow heads) lateral to the normal testis (T). Anechoic areas (F) within the abscess represent fluid due to liquefaction. This abscess originated in the scrotal skin.



(A)



(B)

Figure 10-12A & B Pyocele. Sagittal views demonstrate pyocele with multiple septations surrounding the testis and extending laterally. E—enlarged tail of epididymis.

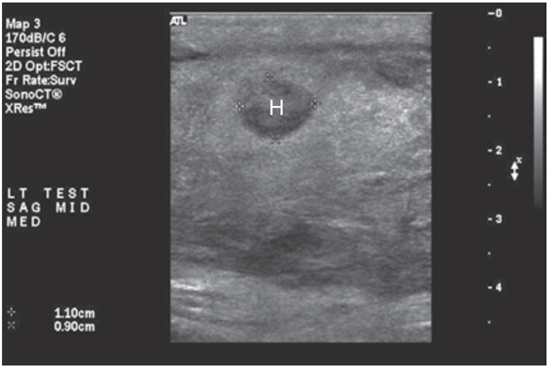


Figure 10-13 Intratesticular hematoma. Small hypoechoic hematoma (H) is seen within the testicle in a patient who sustained blunt testicular trauma. Note that the testicle is enlarged and inhomogeneous.

- Anechoic fluid around testis
- May have internal low-level echoes and thin echogenic septations (Figure 10-15)

Testicular Rupture

- Abnormal contour of testis
- Heterogeneous appearance

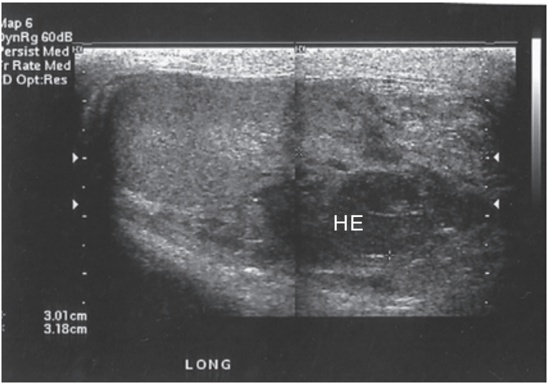
Other Sonographic Findings in Testicular Trauma

- Linear hyperechoic structure within testis representing fracture line
- Enlarged epididymis with focal or increased color Doppler flow (traumatic epididymitis)
- Abnormal intratesticular Doppler flow

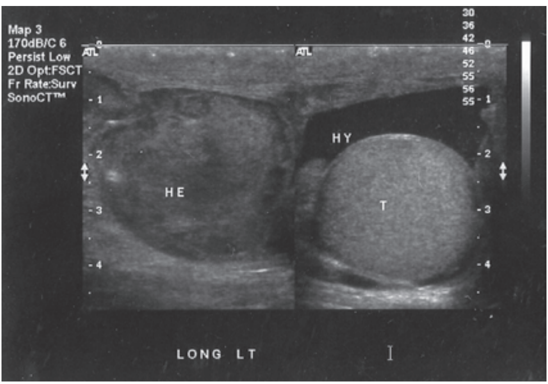
Scrotal Cyst

Intratesticular Cyst

- Occasionally located near mediastinum testis



(A)



(B)

Figure 10-14A & B Extratesticular hematoma. In (A) the hematoma (HE) is hypoechoic and irregular. In (B), the hematoma (HE) is well defined and slightly hypoechoic compared with the normal testis (T). HY—hydrocele.

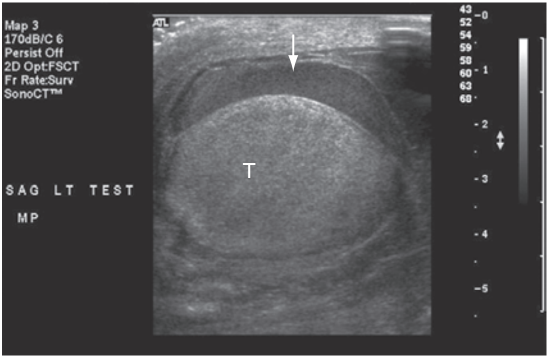


Figure 10-15 Hematocele. Sagittal view showing a hematocele (arrow) with low-level echoes. The normal testis (T) is seen posterior to the hematocele.

- Anechoic mass with smooth walls and posterior enhancement
- Size varies from 2–18 mm.

Tunica Albuginea Cyst

- Located within tunica
- Anechoic with smooth walls and posterior enhancements (Figure 10-16)
- May be filled with low level echoes and mimic a testicular tumor (Figure 10-17)
- Size varies from 2–30 mm.

Epidermoid Cyst

- Well-defined hypoechoic mass with echogenic capsule (Figure 10-18)
- May have central echogenic calcification
- May be multiple or bilateral
- May lack acoustic enhancement
- Vascularity not present within mass

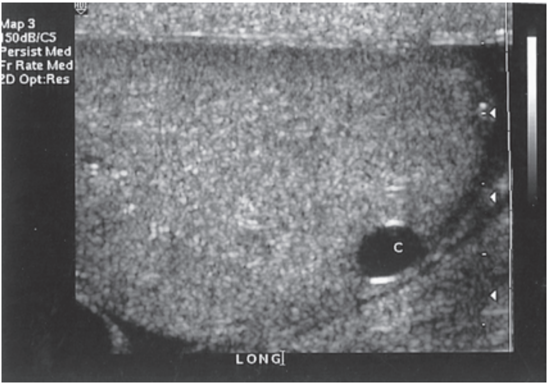


Figure 10-16 Tunica albuginea cyst. Longitudinal view demonstrates a small anechoic cyst (c) on the periphery of the testis.

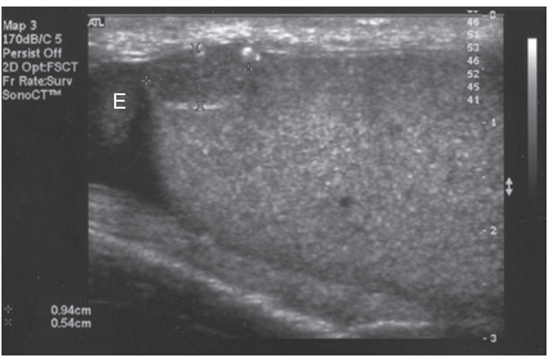


Figure 10-17 Tunica albuginea cyst with echoes. Longitudinal view shows a cyst with echoes (between calipers) that is isoechoic to the adjacent testis parenchyma. This appearance can mimic a testicular tumor. E—head of epididymis.

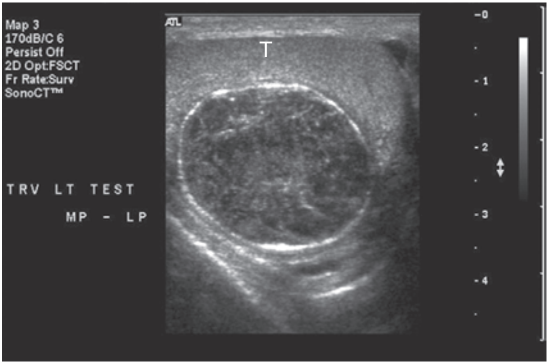


Figure 10-18 Epidermoid cyst. Transverse view of epidermoid cyst presenting as a large heterogeneous mass with echogenic borders. The mass occupies most of the testicular parenchyma (T).

Spermatocele

- Located in head of epididymis
- Anechoic with smooth walls (Figure 10-19)
- May have thin echogenic septations

Testicular Tumors

- Focal or diffuse mass(es) of varying echogenicities
- Seminomas and lymphomas commonly hypoechoic in texture (Figure 10-20A and B)
- Tumor may partially or completely replace normal tissue.
- Enlarged or inhomogeneous epididymis may indicate infiltration by tumor (Figure 10-21A and B).
- Above commonly seen in lymphoma
- Focal hypoechoic tumor may mimic focal orchitis.

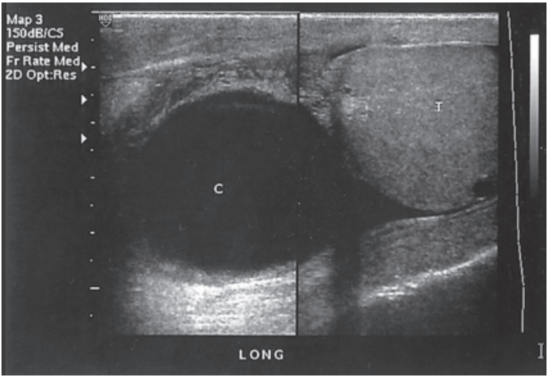


Figure 10-19 **Spermatocele.** Longitudinal view of a large, anechoic spermatocele (C) with posterior enhancement and located superior to the testis (T).

- Associated finding may include lymphadenopathy.

Other Scrotal Pathology

Hydrocele

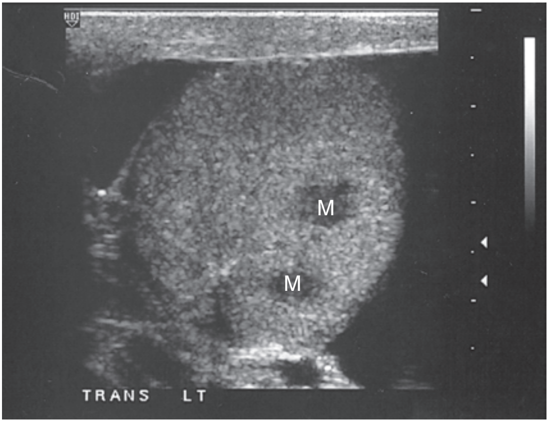
- Anechoic fluid surrounding testis (Figure 10-22)
- Chronic hydroceles may have echogenic linear septations or low-level echoes (Figure 10-23).

Varicocele

- Extratesticular tortuous anechoic tubular structures
- Seen posterior, lateral, or superior to testis
- Measure more than 2 mm (anterior to posterior)
- Color flow present within dilated veins and best demonstrated on erect views with valsalva (Figure 10-24A and B)

Scrotal Hernia

- Extratesticular mass



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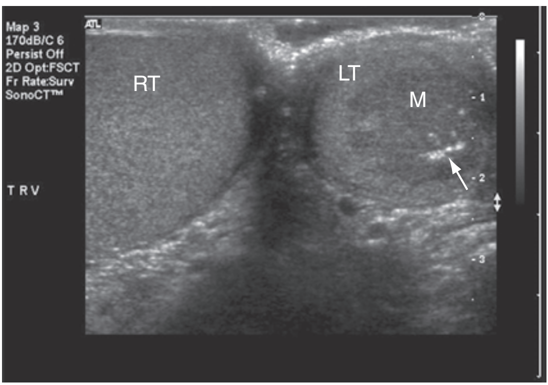
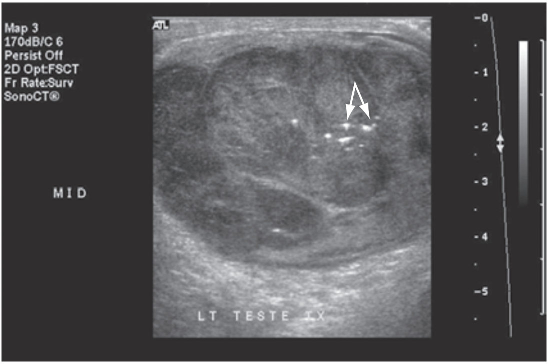


(B)

Figure 10-20A & B Seminoma. In (A), the tumor is seen as focal hypoechoic masses (M). In (B), the tumor presents as a solitary hypoechoic mass (M) with calcifications (arrow). It occupies most of the testis parenchyma (T). The normal homogeneous right testicle (RT) is also seen.



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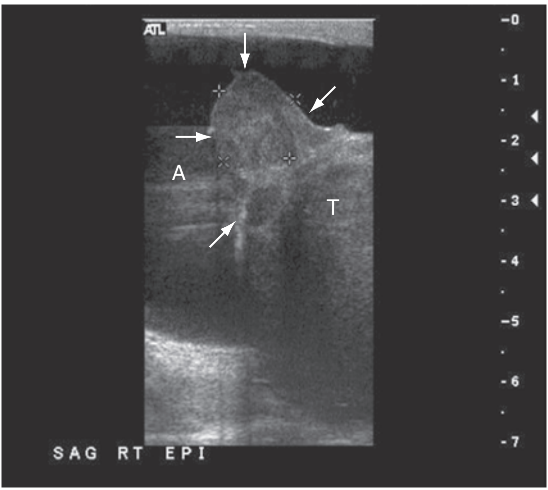


(B)

Figure 10-21A & B Testicular lymphoma. In (A), the testis is almost replaced by a large hypoechoic mass with calcifications (arrows). In (B), the head of the epididymis (between arrows) is enlarged and heterogeneous due to infiltration by tumor. T—testis, Area A—scanning artifacts.

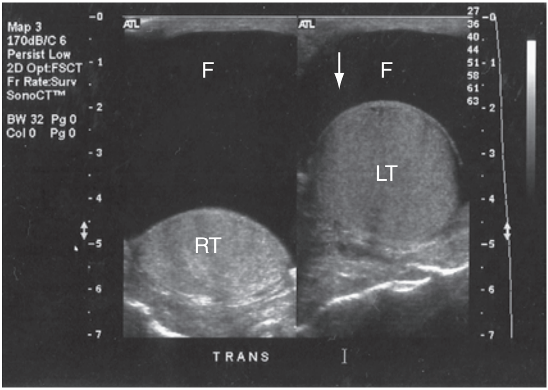


Figure 10-22 Bilateral hydrocele. Transverse views of the scrotum show anechoic fluid (F) surrounding normal right (RT) and (LT) testes.

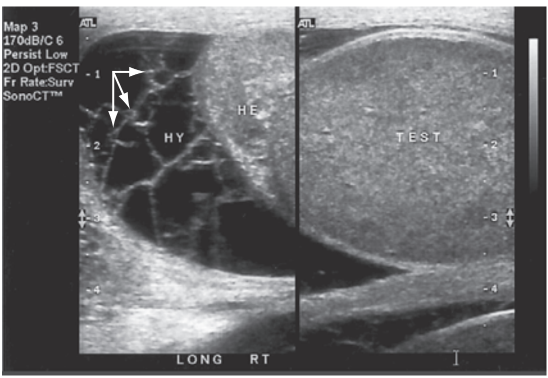
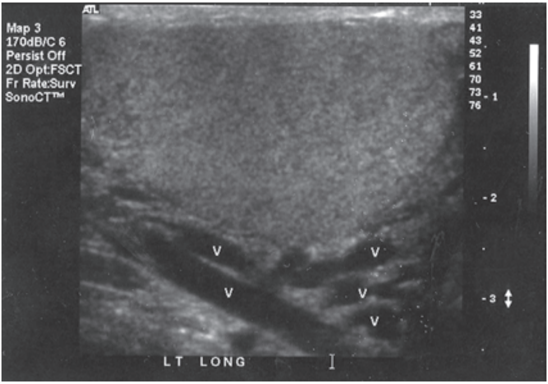
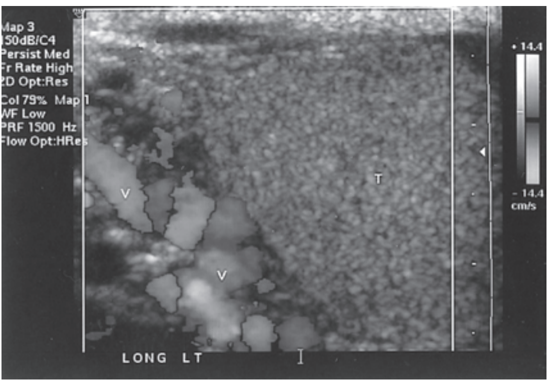


Figure 10-23 Chronic hydrocele. Longitudinal view demonstrates a hydrocele (HY) with multiple septations (arrows). TEST—testicle, HE—head of epididymis.



(A)



(B)

Figure 10-24A & B Varicoceles. In (A), varicocele is seen as multiple tubular anechoic structures (V). In (B), dilated veins demonstrate flow on color Doppler (see color inserts).

- Anechoic with echogenic areas (Figure 10-25)
- Peristalsis present within mass

Cryptorchidism (Undescended Testis)

- Most commonly located in the inguinal canal
- Testis may be small and slightly less echogenic than normally descended testis.

Microlithiasis

- Multiple small echogenic foci within testicle (Figure 10-26)
- Shadowing not commonly seen
- Calcifications commonly seen bilaterally

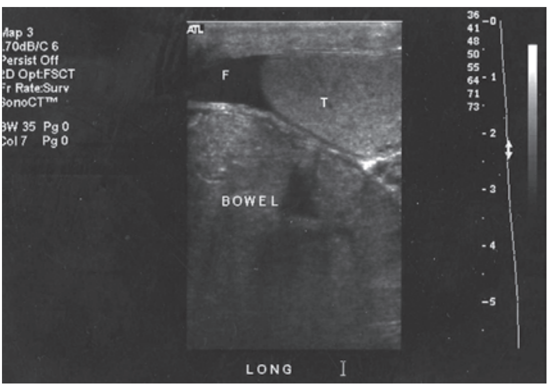


Figure 10-25 Scrotal hernia. A large hypoechoic mass (BOWEL) is seen adjacent to the testis (T). Bowel peristalsis was observed during the exam. F—fluid.

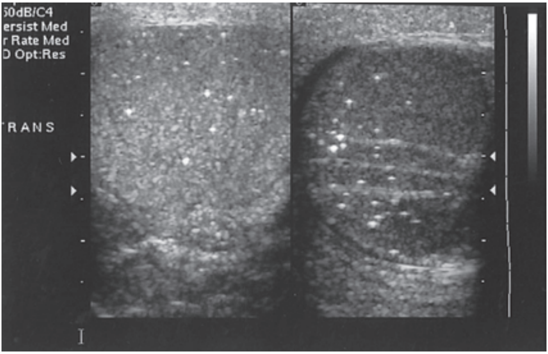


Figure 10-26 Microlithiasis. Transverse view of the testes demonstrates diffuse echogenic foci bilaterally.

Chapter 11: Lower Extremity Pathology

KALANI FERNANDO AND DUNSTAN ABRAHAM

Popliteal Fossa Cyst (Baker's Cyst)

- Anechoic cystic mass in popliteal fossa
- May have linear echogenic septations or low-level echoes (Figure 11-1)
- May extend into calf region
- Should not be mistaken for popliteal artery aneurysm (see below)

Popliteal Artery Aneurysm

- Focal dilation of popliteal artery
- Pulsatile on real-time imaging
- May contain low-level echoes (clots)
- Walls may be echogenic because of calcification.
- Flow seen within vessel on color Doppler

Calf Hematomas and Abscesses

- Variable appearance
- Cystic, solid, or complex mass within muscle (Figure 11-2A and B)
- Localized anechoic fluid collection within muscle

Cellulitis

- Diffuse thickening of soft tissues (Figure 11-3)
- Tissue borders with increased echogenicity
- Increased vascularity within tissue on color Doppler

Pseudoaneurysms

- May develop after penetrating trauma or arterial catheterization

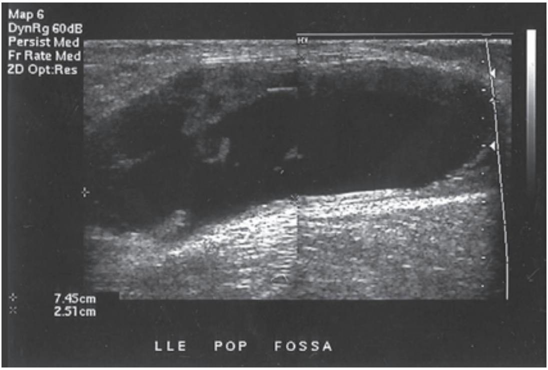
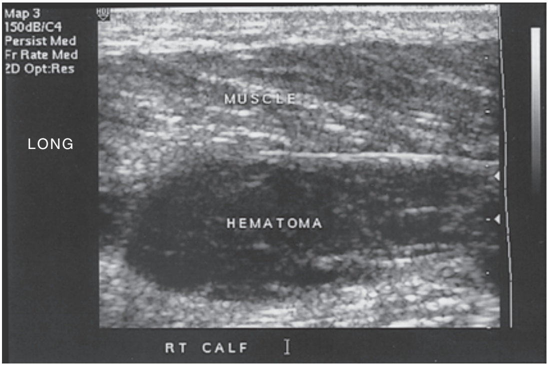


Figure 11-1 Popliteal fossa cyst. Longitudinal image shows a large predominantly cystic mass (between calipers) with echoes. These echoes most likely represent hemorrhage.

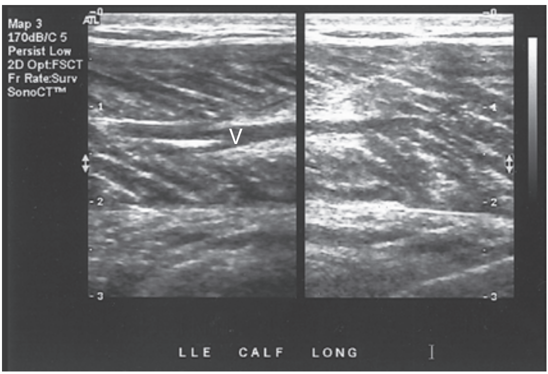
- Saccular anechoic mass adjacent to the femoral artery (Figure 11-4)
- Flow seen within mass
- Compression with transducer pressure often used to promote clotting

Foreign Bodies

- Glass, metal, and plastic are sometimes localized in extremities.
- Foreign bodies are seen as echogenic foci with posterior shadowing.
- Metal and glass are more echogenic than wood or plastic.



(A)



(B)

Figure 11-2A & B Calf hematoma. In (A), complex mass (hematoma) is seen within gastrocnemius muscle (muscle). This patient sustained injury to his calf after falling from a bicycle. (B) demonstrates the normal contralateral gastrocnemius muscle. V—tibial vessel.

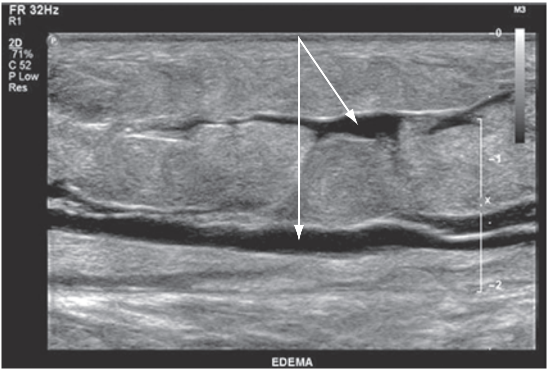


Figure 11-3 Cellulitis. Image demonstrates thickening of the soft tissues of the calf with fluid areas (arrows).

Source: Courtesy of Phillips, reprinted with permission.

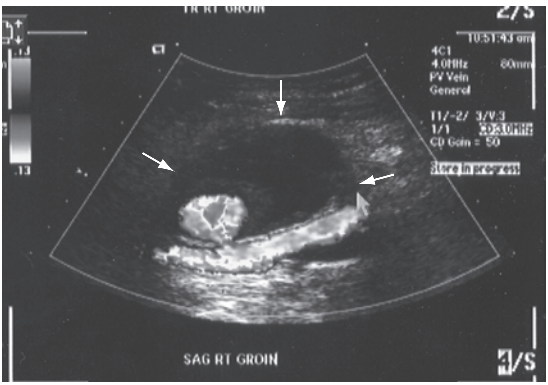


Figure 11-4 Pseudoaneurysm. Color Doppler of femoral artery shows flow (arrows) entering anechoic pseudoaneurysm (see color inserts).

Chapter 12: Fluid Collections and Ultrasound Guided Procedures

KALANI FERNANDO AND DUNSTAN ABRAHAM

Fluid Collections

Ascites

- Anechoic-free fluid
- May have echogenic floating loops of bowel (Figure 12-1)
- May have septations, debris, or matted bowel loops (associated with hemorrhage, infections, or malignancy) (Figure 12-2)
- Locations: perihepatic, subhepatic, Morrison's pouch, perisplenic, paracolic gutters (flanks), and pelvis
- Gravity-dependent motion seen

Pleural Effusion

- Anechoic collection of fluid located superior to the diaphragm
- Seen via liver on right and spleen on left
- May be seen surrounding echogenic lung tissues (Figure 12-3)
- May have echogenic particles or echogenic septations that are associated with inflammation or neoplasms (exudates)

Ultrasound-Guided Procedures

It is beyond the scope of this pocket guide to discuss the technical details involved in ultrasound-guided procedures; however, we will mention a few areas where ultrasound is commonly used to assist invasive procedures. The reader can obtain more information from the suggested reading list at the end of the book.

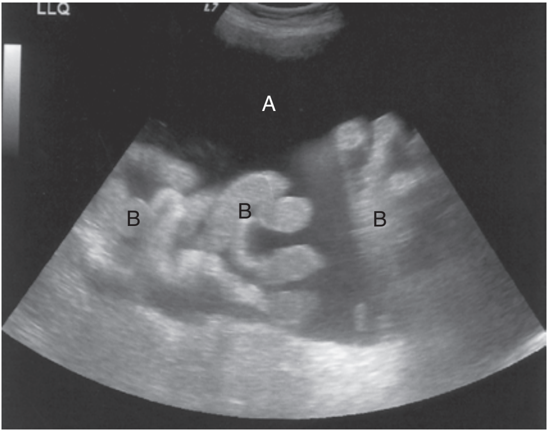


Figure 12-1 Floating bowel loops. Longitudinal image demonstrating anechoic ascites (A) with floating echogenic bowel loops (B).

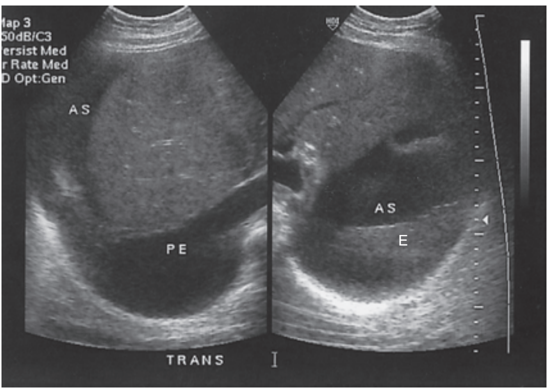


Figure 12-2 Malignant ascites. Transverse view of the upper abdomen demonstrates ascites (AS) around liver and in left abdomen. The larger collection contains medium-level echoes (E). This patient had a large malignant ovarian tumor. PE—pleural effusion.

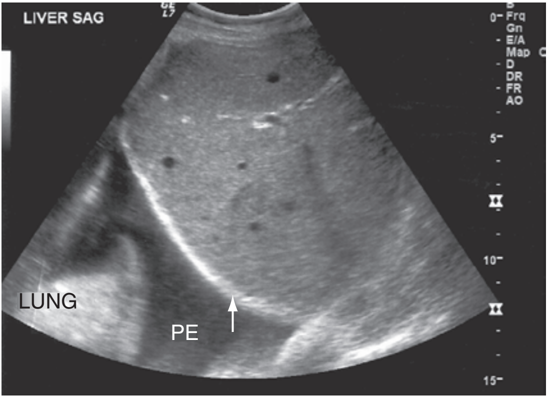


Figure 12-3 **Pleural effusion.** Longitudinal view shows anechoic pleural effusion (PE) superior to the right hemidiaphragm (arrow). Echogenic lung tissue (LUNG) is surrounded by pleural effusion.

Commonly Performed Ultrasound-Guided Procedures

- Thoracentesis
- Cyst puncture
- Mass biopsy (Figure 12-4)
- Abscess drainage
- Vascular access

Vascular Access

Ultrasound is commonly used for central venous access (subclavian or internal jugular veins) or difficult peripheral veins. Ultrasound imaging can provide the following information:

- Locate vessel
- Select best site for needle insertion
- Determine vessel depth
- Determine best angle for needle insertion
- Follow needle as it enters vessel

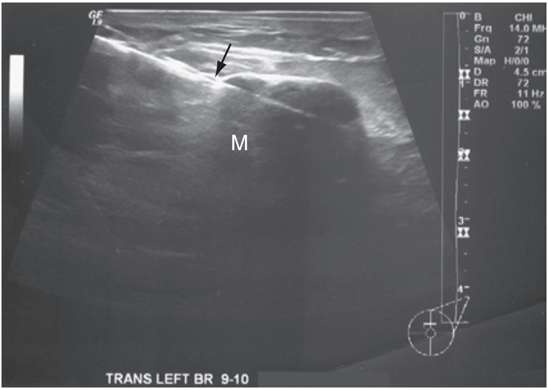


Figure 12-4 Breast mass biopsy. Echogenic needle (arrow) is seen entering hypoechoic breast mass (M).

Summary

Abdominal organs are evaluated using several characteristics to distinguish normal from abnormal appearance. The following list names some characteristics that are documented and analyzed on routine sonography:

- Location (normal, ectopic, or displaced)
- Size (normal or enlarged)
- Echogenicity (anechoic, hypoechoic, or hyperechoic)
- Homogeneity (homogeneous or heterogeneous)
- Shape (normal or irregular)
- Borders (smooth or irregular)
- Vascularity (normal, increased, decreased, or absent)

Abdominal pathologies exhibit a wide spectrum of sonographic appearances, depending on the etiology and extent of disease. The ultrasound findings are variable and may include an inhomogeneous

organ, a mass within an organ, or mass adjacent to an organ. Changes in vascular flow may also indicate the presence of pathology. The following are some sonographic characteristics that should be documented when an abdominal mass is identified:

- Location (within or outside borders of organ)
- Size (measurement in three dimensions)
- Echogenicity (anechoic, hypoechoic, hyperechoic, or mixed)
- Homogeneity (homogeneous or heterogeneous)
- Shape (round, oval, tubular, etc.)
- Borders (smooth or irregular)
- Posterior enhancement (poorly enhancing or well enhancing)
- Presence of shadowing (clean or dirty)
- Presence of attenuation
- Presence and degree of vascularity
- Displacement of vessels, organs, or structures
- Presence of peristalsis or changes in size or shape (seen with bowel)
- Compressibility with transducer (seen with bowel)

In addition to these, other findings such as ascites and lymphadenopathy may provide information that may point to the correct diagnosis.

Chapter 13: The Uterus

CYNTHIA SILKOWSKI

Pelvic sonography can be performed using two approaches. The transabdominal approach requires the patient to have a filled urinary bladder. The transvaginal approach is performed on patients with an empty urinary bladder.

The transabdominal approach allows for a more global view of the pelvis. This is especially helpful when performing an examination for an enlarged uterus or pelvic mass. When performing transabdominal imaging, the transducer is usually of low to medium range of frequencies. The highest frequency transducer, which provides optimal penetration of tissue, is used. When using the transvaginal approach, the transducer is at a higher frequency, which allows for better resolution of the endometrial cavity and ovaries but at a loss of penetration. Also, the field-of-view is more limited with the transvaginal probe.

Transabdominal and transvaginal imaging methods complement each other. Transabdominal imaging should be performed routinely and transvaginal imaging when necessary to supplement an examination to avoid diagnostic errors.

Some contraindications for using transvaginal scanning include patients who are virgins or unconscious, who have psychological problems, who are under the influence of controlled substances, or obstetrical patients who might have a placenta previa.

Normal Sonography of the Uterus

- Divided into fundus, corpus, isthmus, and cervix (Figure 13-1)
- Size and contour (shape) vary with age, hormonal status, and parity.

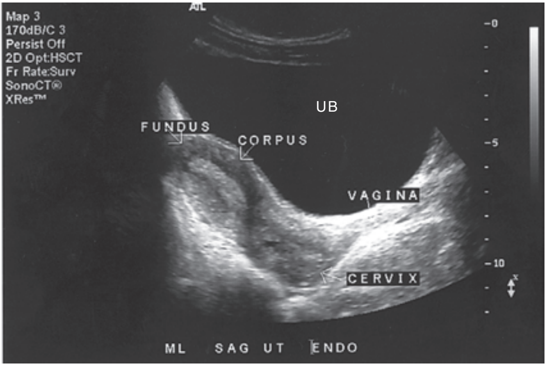


Figure 13-1 Uterine divisions. Transabdominal sagittal image demonstrating the divisions of the uterus. Urinary bladder (UB).

- Mean measurements for nulliparous female is 8 × 5 × 4 cm (length × width × Anterior and Posterior (AP) diameter) (Figure 13-2A and B)
- Parity may increase each dimension by more than 1 cm.

Layers of the Uterus

- Perimetrium: not visualized
- Myometrium: homogeneous, midlevel echoes
- Endometrium:
  - Midline endometrial stripe represents interface between two endometrial layers; appears as thin echogenic line (Figure 13-3).
  - Thickness and echogenicity vary with phase of menstrual cycle (see below) and age.

The Vagina

- Midlevel echoes similar to the myometrium
- Midline echogenic stripe (arrow heads) represents interface between the walls of the vagina (Figure 13-3).

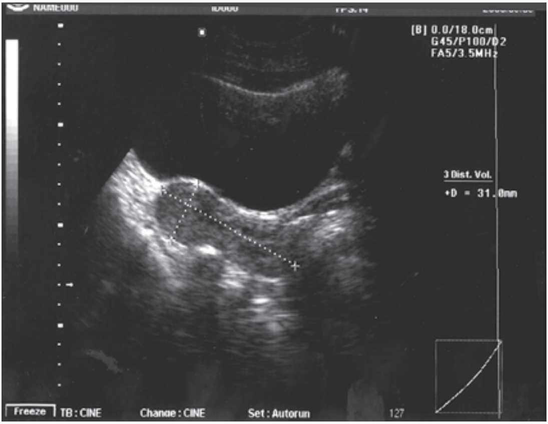


Figure 13-2A Uterine measurements. Transabdominal sagittal image demonstrating the proper placement of caliper markers measuring both the length and anterior/posterior diameter of the uterus.

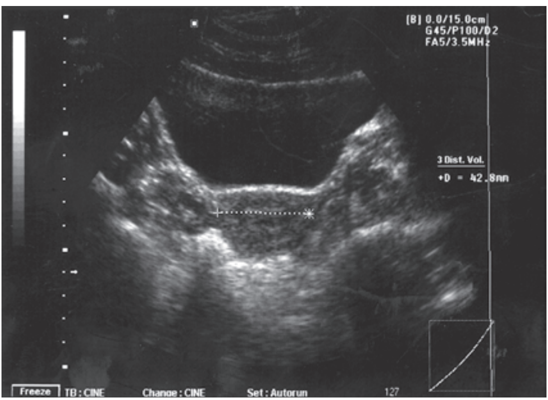


Figure 13-2B Transabdominal transverse image demonstrating the proper placement of caliper markers to measure the width of the uterus.

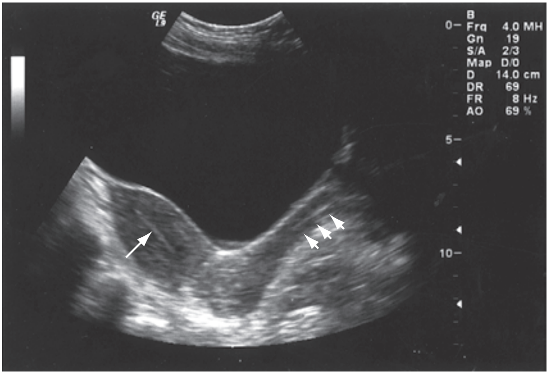


Figure 13-3 Endometrial stripe and vagina. Transabdominal sagittal image in a midline plane of the uterus and vagina demonstrating the echogenic endometrial stripe (arrow) representing opposed surfaces of the endometrial layers. Echogenic interface (arrowheads) between the anterior and posterior vaginal walls.

Measurement of the Endometrium

- Endometrium measured on midline sagittal plane of the uterus in A/P dimension
- Both anterior and posterior layers of endometrium included in measurement (Figure 13-4)
- Outer hypoechoic layer represents the inner layer of myometrium and not included in measurement
- May see acoustic enhancement posterior to endometrial layer

The Menstrual Cycle—Sonographic Appearances of Endometrium

Menstrual Phase

- Variable appearance

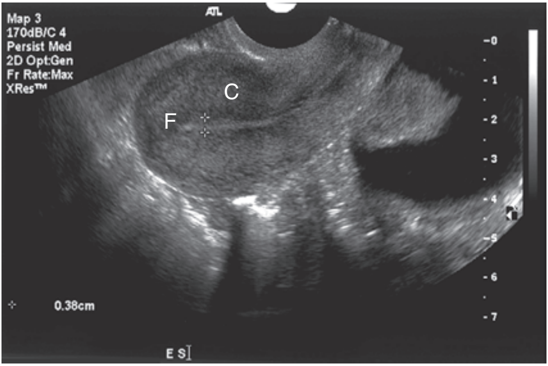


Figure 13-4 Endometrial measurement. Transvaginal sagittal image in a midline plane demonstrating the uterine corpus (C) and fundus (F) with proper placement of calipers to measure the endometrium.

- Endometrial cavity may contain menstrual contents that may appear anechoic, complex, or echogenic.
- May see thin, broken echogenic midline stripe

Proliferative Phase

- Functional layers are hypoechoic.
- 4–8 mm in AP diameter

Late Proliferative/Periovulatory Phase

- Triple-layer appearance: central echogenic line, adjacent thicker hypoechoic functional layers, and outer echogenic basal layers
- 6–10 mm in AP diameter

Secretory Phase

- Thickened hyperechoic endometrium (Figure 13-5)
- 7–14 mm in AP diameter

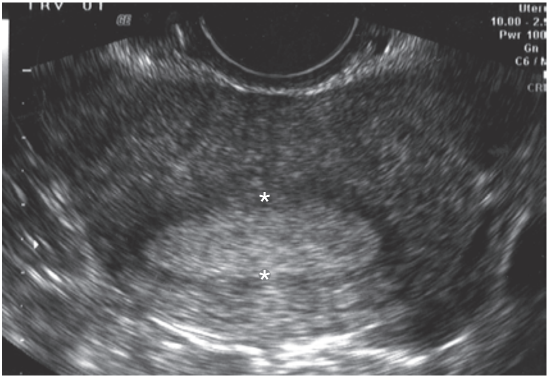


Figure 13-5 Secretory endometrium. Transvaginal coronal image of the uterus demonstrating a thickened prominent hyperechoic secretory endometrium within markers.

Postmenopausal Endometrium—Asymptomatic Female

- Thin echogenic line
- Approximately less than 5 mm in A/P diameter

Uterine Location and Positions

- Located in midline or deviated to right or left side
- Anteverted (most common position) (Figure 13-6) and/or anteflexed
- Retroverted (Figure 13-7A) and/or retroflexed (Figure 13-7B)
- Overdistended urinary bladder may deviate uterus to either side.

Common Congenital Variations Seen on Ultrasound

Septate/Subseptate Uterus (Most Common)

- Partial or complete failure of resorption of median septum

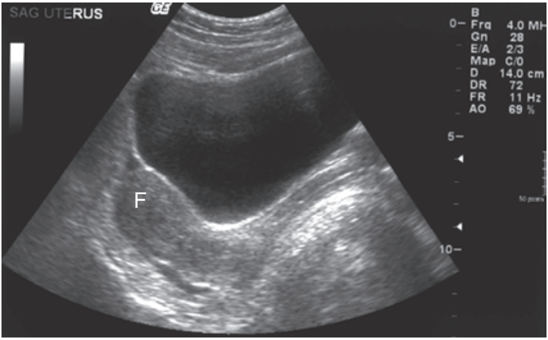


Figure 13-6 Anteverted uterus. Transabdominal sagittal image in a midline plane of the uterus demonstrating an anteverted uterus. Note the position of the uterine fundus (F).

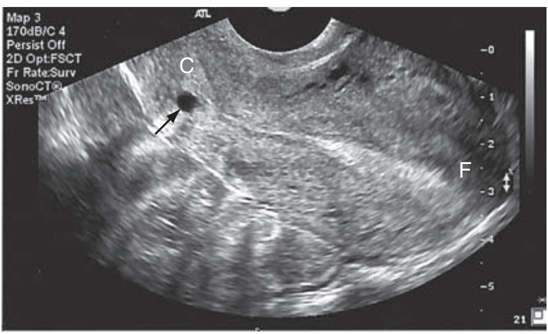


Figure 13-7A Retroverted uterus. Transvaginal sagittal image demonstrating a retroverted uterus. The entire uterus is tilted posteriorly in relation to the vagina. Uterine fundus (F). Note the anechoic structure within the cervix (C) representing a Nabothian cyst (arrow).

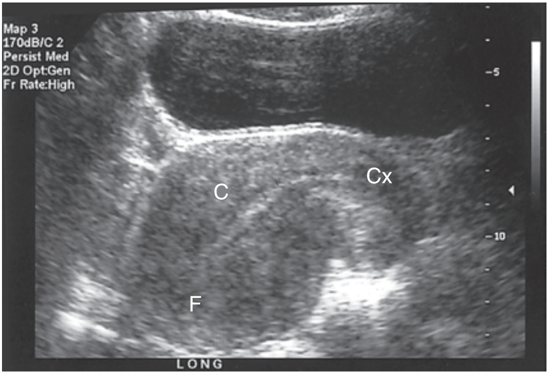


Figure 13-7B Retroflexed uterus. Transabdominal sagittal image demonstrating a retroflexed uterus. The corpus (C) of the uterus is tilted posteriorly in relation to the cervix (Cx). Fundus (F).

- Partial or complete duplication of uterine cavities without duplication of uterine horns
- Can visualize two endometrial echoes
- Endometrial echoes closely related and separated by thin fibrous septum (Figure 13-8)
- Outline of uterus appears normal.

Bicornuate Uterus

- Duplication of uterine horns and sometimes cervix
- Bilobed uterine cavity seen
- Can visualize two endometrial echoes and sometimes endocervical echoes
- Endometrial echoes widely separated
- Deep indentation (greater than 10 mm) on fundal contour of uterus (Figure 13-9)

Uterine Didelphys

- Complete duplication of uterus, cervix, and vagina
- Can visualize two endometrial echoes

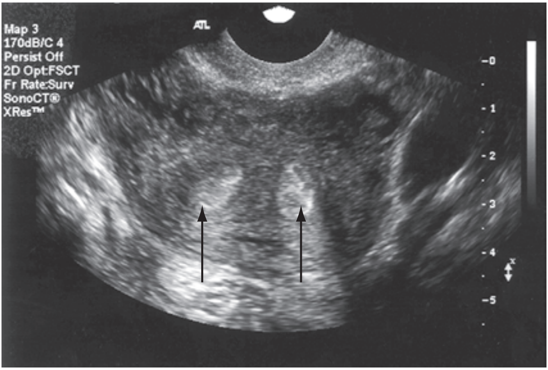


Figure 13-8 Septate uterus. Transvaginal coronal image demonstrating two endometrial echoes (arrows) closely related. Note that the outline of the uterus appears normal.

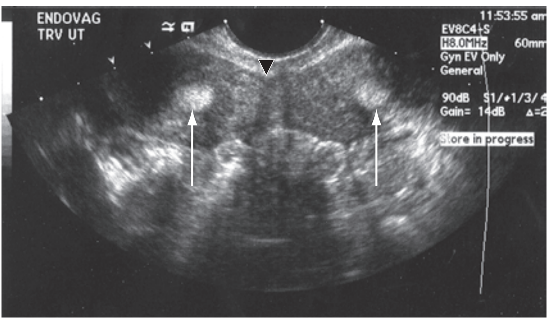


Figure 13-9 Bicornuate uterus. Transvaginal coronal image demonstrating two endometrial echoes (arrows) widely separated. Note the indentation on the fundal contour of the uterus (arrow head).

- Endometrial echoes widely separated (Figure 13-10)
- Can visualize two endocervical echoes
- May have hypoechoic fibrous bands of tissue connecting both uteri

Pathology

Leiomyoma (Myoma, Fibroid)

May present with one or more of the following sonographic appearances:

- Enlarged uterus (diffuse or localized)
- Lobular, distorted uterine contour
- Displaced/eccentric endometrial echo
- Discrete mass(s) of various echogenicities within uterus (Figure 13-11)
- Hypoechoic to anechoic mass with good sound transmission (due to cystic degeneration)
- Hypoechoic to anechoic mass with poor sound transmission (due to hyaline degeneration)

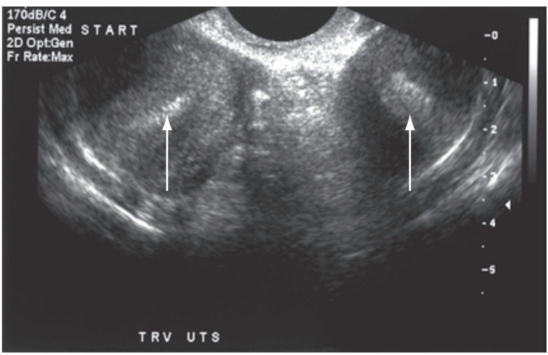


Figure 13-10 Uterine didelphys. Transvaginal coronal image demonstrating two endometrial echoes (arrows) widely separated but more distinctive of a didelphys as both horns appear separate.

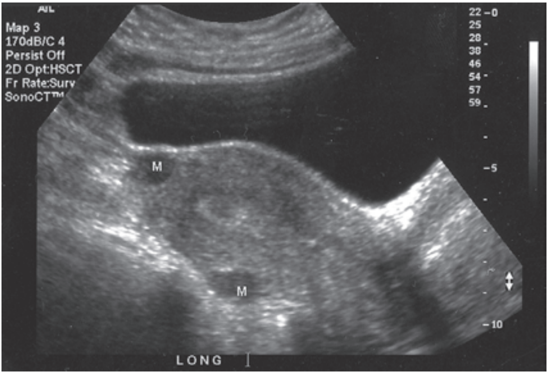


Figure 13-11 **Leiomyoma.** Transabdominal sagittal image demonstrating two discrete hypoechoic myomas (M).

- Focal or circular echogenic areas with posterior acoustic shadowing (due to calcific degeneration) (Figure 13-12A and B)

Fibroids Categorized by Location

- Cervical: size of cervical diameter increased (may mimic advanced cervical carcinoma) (Figure 13-13)
- Submucosal: nonvisualization or partial visualization of linear endometrial echo with mass-like appearance within uterine cavity (Figure 13-14)
- Interstitial (intramural): may displace endometrial echo interface eccentrically (Figure 13-15)
- Subserous: may distort uterine contour (Figure 13-16)
- Pedunculated serous: appears as adjacent adnexal mass (Figure 13-17); look for a connecting stalk to the uterus.

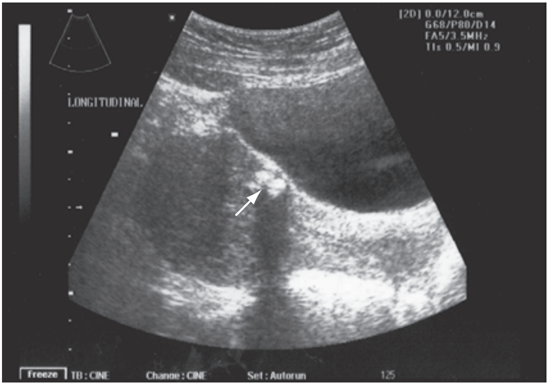


Figure 13-12A Leiomyoma with focal calcifications. Transabdominal sagittal image demonstrating focal calcifications (arrow) within a myoma with posterior acoustic shadowing.

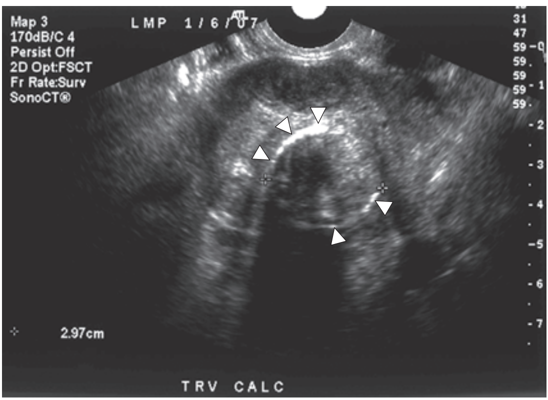


Figure 13-12B Leiomyoma with a calcified ring. Transvaginal coronal image demonstrating a myoma with a circular echogenic rim (arrowheads).

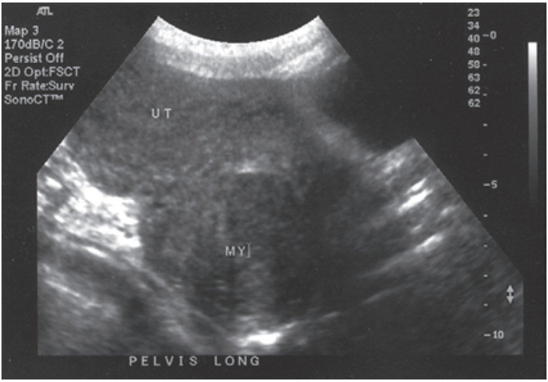


Figure 13-13 Cervical myoma. Transabdominal sagittal image demonstrating a cervical myoma (MY). Note the increased size of the cervix. Uterus (UT).

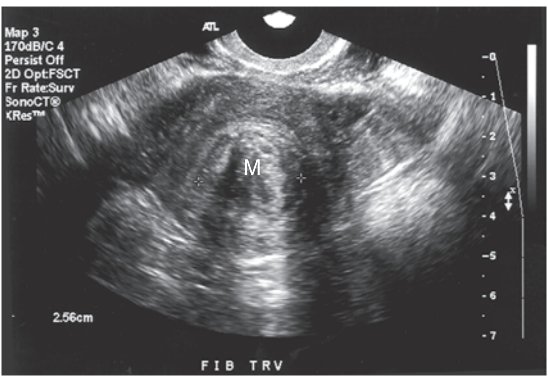


Figure 13-14 Submucosal myoma. Transvaginal sagittal image of the uterus demonstrating a myoma (M) with a mass-like appearance within the uterine cavity. Note the nonvisualization of the endometrial echo interface.

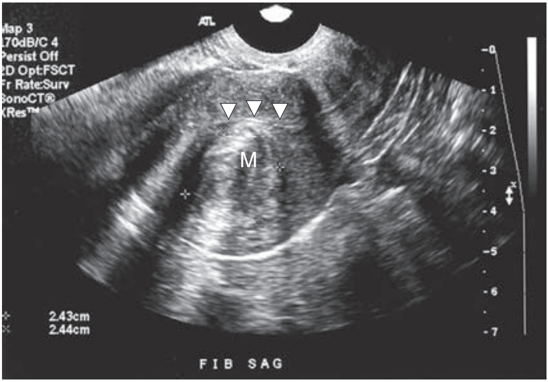


Figure 13-15 Interstitial (intramural) myoma. Transvaginal sagittal image of the uterus demonstrating an intramural myoma (M) displacing the endometrial echo interface (arrowheads).

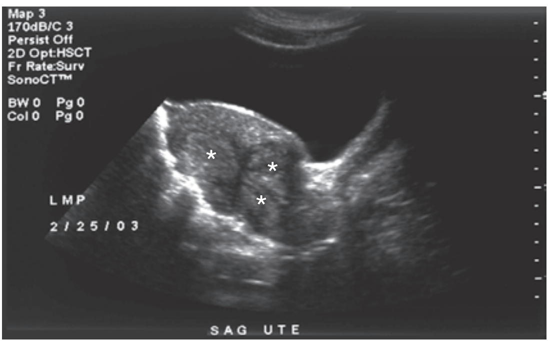


Figure 13-16 Subserosal myoma. Transabdominal sagittal image demonstrating an inhomogeneous uterus containing multiple myomas (*) distorting the uterine contour.

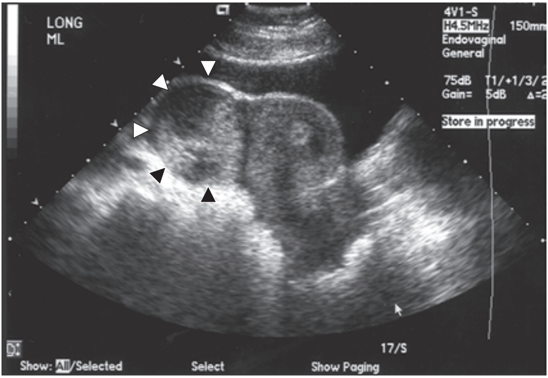


Figure 13-17 Pedunculated serous myoma. Transabdominal sagittal image showing a pedunculated serous myoma (arrowheads). Note the distortion of the uterine contour.

- Rapidly growing myomas may indicate malignancy (leiomyosarcoma), especially after menopause.

Sonohysterography (saline infusion into endometrial cavity) can be helpful to differentiate submucosal myomas from endometrial polyps and endometrial carcinomas (discussed later).

Adenomyosis

- Endometrial tissue within myometrium
- Diffuse and nodular forms visualized

Diffuse Adenomyosis

Diffuse adenomyosis may present with one or more of the following sonographic appearances:

- Diffuse uterine enlargement
- Heterogeneous myometrium with increased/decreased areas of echogenicity

- Diffuse shadows thought to be caused by hypertrophy of smooth muscles (Figure 13-18)
- Asymmetrical thickening of myometrium (more commonly on posterior aspect)
- Myometrial cysts
- Endometrial/myometrial borders poorly defined
- Subendometrial echogenic linear striations projecting into myometrium

Nodular Adenomyosis (Adenomyoma)

- Circumscribed nodules with indistinct margins within myometrium
- Can be differentiated from a fibroid which has distinct margins and "mass-like" appearance
- Anechoic areas visualized

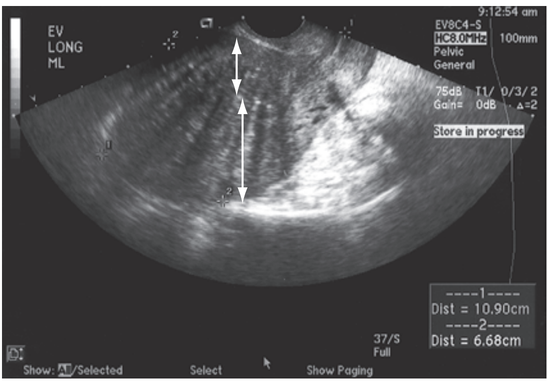


Figure 13-18 Diffuse adenomyosis. Transvaginal sagittal image demonstrating uterine enlargement with asymmetrical thickening of the myometrium and diffuse shadows typical of adenomyosis. Note the asymmetry when comparing the two distance lines.

Endometrial Hyperplasia

- Postmenopausal bleeding patients need further evaluation when endometrium is equal to or greater than 5 mm
- Focal or diffusely thickened echogenic endometrium (Figure 13-19A and B)
- Well-defined margins
- May be asymmetrical
- May contain cystic (anechoic) areas within thickened endometrium
- Can mimic endometrial polyp or carcinoma

Endometrial Polyp

- Focal or diffusely thickened hyperechoic endometrium
- Round, echogenic mass in endometrial cavity
- May have small cystic (anechoic) areas within polyp (Figure 13-20)
- May extend into cervix or vagina

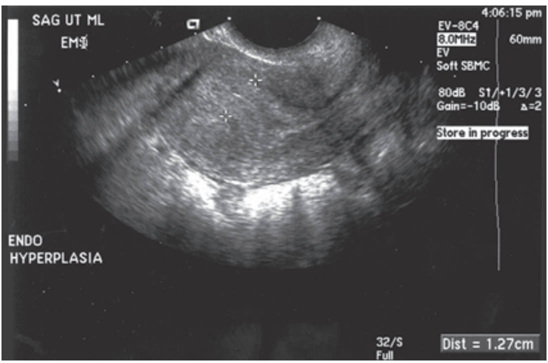


Figure 13-19 Endometrial hyperplasia. Transvaginal sagittal image demonstrating a prominently thickened echogenic endometrium (between cursors) in a postmenopausal female.

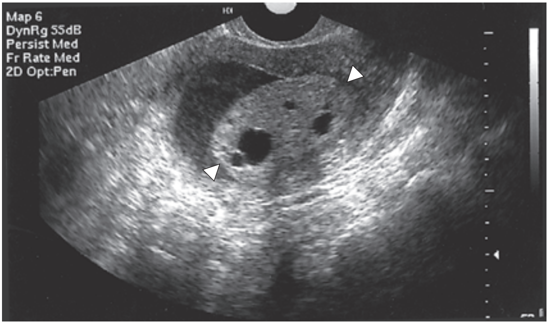


Figure 13-20 Endometrial polyp. Transvaginal coronal image demonstrating an echogenic solid mass within the uterine cavity containing small anechoic areas.

- May see visible stalk (Figure 13-21) (check with Doppler)
- Can mimic endometrial hyperplasia or endometrial cancer
- Polyp best seen using sonohysterography (saline infusion into the endometrial cavity)

Endometrial Carcinoma

- Thickened heterogeneous endometrium (Figure 13-22A)
- Well or poorly defined borders
- Can mimic endometrial hyperplasia, polyps, or myoma (Figure 13-22B)

Possible Associated Secondary Signs of Malignancy

- Ascites (free fluid in the pelvis that may contain echoes) (Figure 13-23)
- Lymphadenopathy (hypoechoic masses adjacent to vessels)
- Distant metastasis

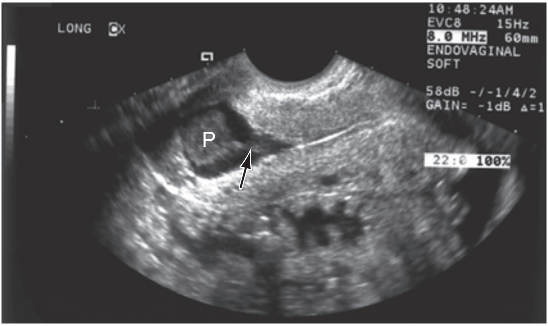


Figure 13-21 Endometrial polyp. Transvaginal sagittal image demonstrating an echogenic solid mass within the uterine cavity. Note the visible stalk (arrow) attaching the polyp (P) to the endometrium.

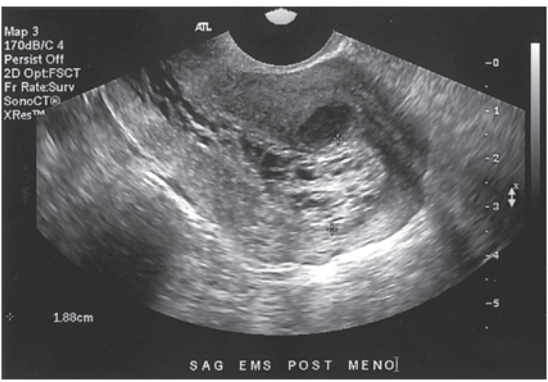


Figure 13-22A Endometrial carcinoma. Transvaginal sagittal image demonstrates endometrial carcinoma presenting as a thickened heterogeneous irregular endometrial mass within the uterine cavity.

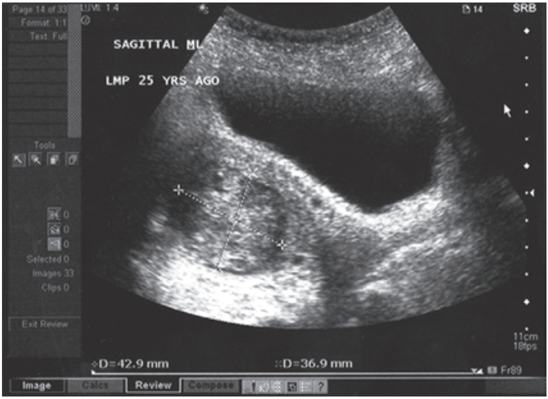


Figure 13-22B Endometrial carcinoma. Transabdominal sagittal image of the uterus demonstrating endometrial carcinoma presenting as a complex mass (inside cursors) within the uterine cavity mimicking a submucosal myoma.

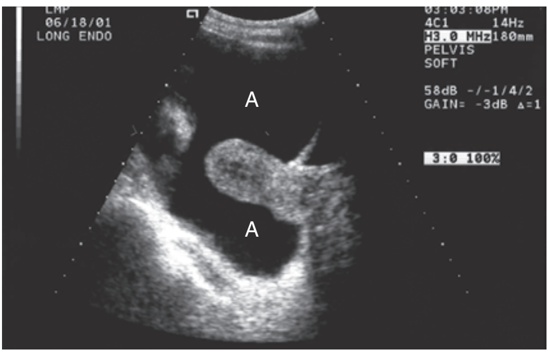


Figure 13-23 Ascites. Transabdominal sagittal image demonstrating ascites (A) filling the pelvis of a patient with ovarian carcinoma.

Intrauterine Contraceptive Devices (IUCD)

- Some types include Copper 7, Copper T, Mirena, and Lippies Loop.
- Most common types used in the Unites States are T-shaped.
- Copper T seen as prominent hyperreflective linear echoes within uterine cavity (Figure 13-24A)
- Lippies loop seen as prominent hyperreflective interrupted linear echoes within uterine cavity (Figure 13-24B)
- Entrance–exit reflections seen as an echogenic double line that represents anterior and posterior surfaces of IUCD (Figure 13-24C)
- May present with posterior acoustic shadowing dependent on transducer frequency and/or beam angle

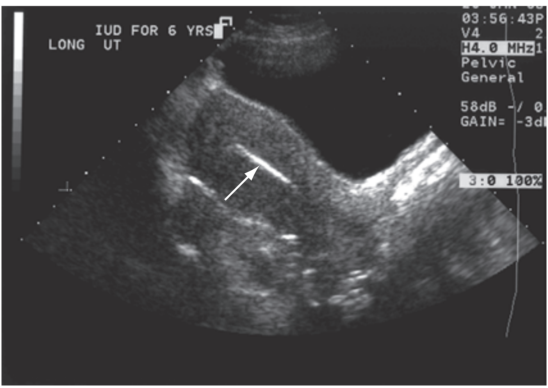


Figure 13-24A IUCD in situ. Transabdominal sagittal image demonstrating a highly echogenic linear IUCD within the uterine cavity, which is properly located in the body of the uterus.

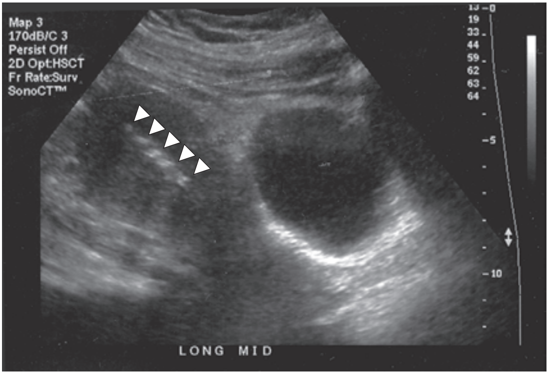


Figure 13-24B Transabdominal sagittal image demonstrating highly reflective interrupted linear echoes (arrowheads) within the endometrial cavity. Note the acoustic shadows posterior to the IUCD.

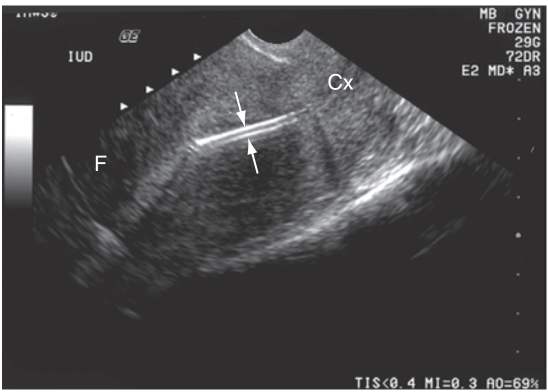


Figure 13-24C Transvaginal sagittal image demonstrating a highly echogenic linear IUCD within the uterine cavity properly located in the body of the uterus. Note the entrance–exit reflections (arrows) representing the anterior and posterior surfaces of the IUCD. Cervix (Cx), Uterine fundus (F).

Complications of IUCD

Malposition

- IUCD echo seen in lower uterine segment (Figure 13-25A and B)

Perforation

- IUCD echo extending outside endometrial cavity and into myometrium or adnexa (Figure 13-26)
- Eccentric position of IUCD

Nonvisualization Within Uterus

- May indicate complete perforation or expulsion via vagina
- In unusual cases may be visualized in the adnexa

Nabothian (Inclusion) Cyst

- Commonly seen cervical cyst(s) (Figure 13-27)
- Anechoic, round, posterior enhancement

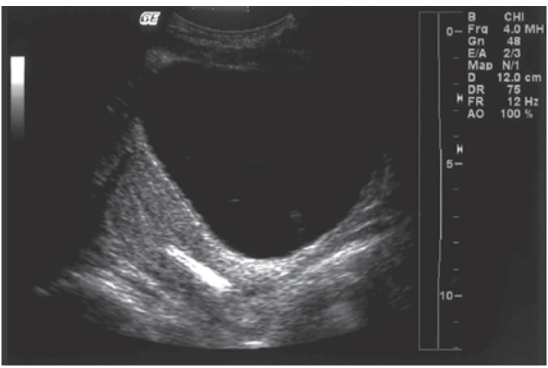


Figure 13-25A Abnormally positioned IUCD. Transabdominal sagittal image demonstrating highly reflective linear echoes within the lower uterine segment consistent with an abnormally positioned IUCD.

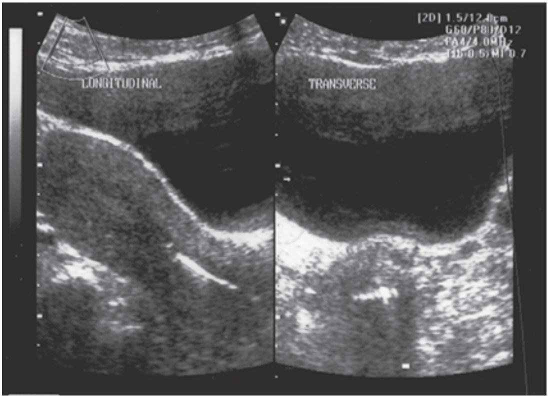


Figure 13-25B Transabdominal sagittal and transverse images demonstrating highly reflective linear echoes within the lower uterine segment consistent with an abnormally positioned IUCD.

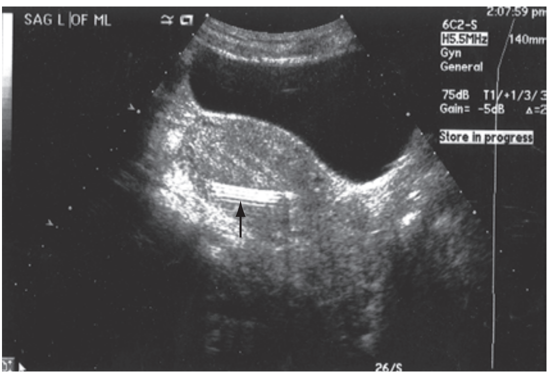


Figure 13-26 Perforated IUCD. Transabdominal sagittal image with highly echogenic linear IUCD (arrow) located within the myometrium consistent with a perforated IUCD. There is a small area of shadowing posterior to the IUCD.

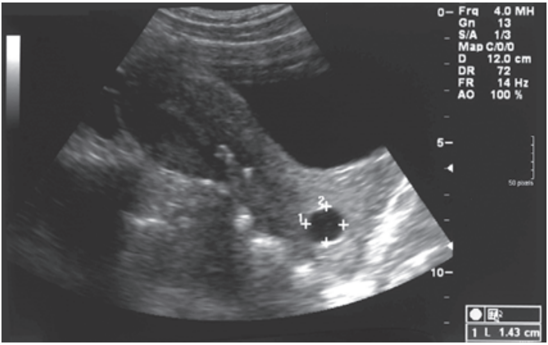


Figure 13-27 Nabothian cyst. Transabdominal sagittal image of the uterus demonstrating an anechoic, well-circumscribed mass (within markers) located in the cervical region of the uterus representing a single commonly seen Nabothian cyst.

- May see internal echoes due to hemorrhage or infection
- Ranges in size from a few millimeters to 4 cm
- May cause benign enlargement of the cervix

Evaluation of Post Hysterectomy Pelvis

- Vaginal cuff normally measures up to 2.1 cm in A/P diameter.
- Above must be evaluated for changes in size, echogenicity, contour, and/or presence of masses (Figure 13-28).
- In patients with history of uterine carcinoma, changes in above features may indicate recurrent disease.
- Echogenic bowel can occupy uterine space and mimic normal uterus (endometrial stripe will not be demonstrated) (Figure 13-29).

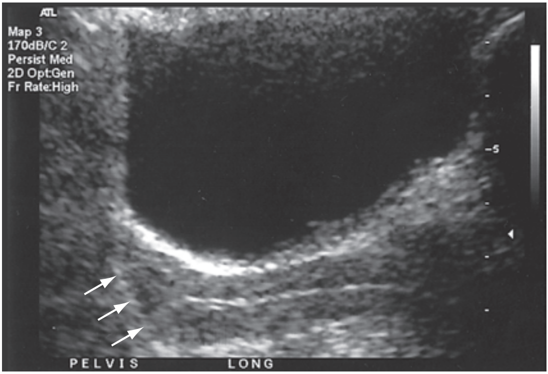


Figure 13-28 Vaginal cuff. Transabdominal sagittal image of the vagina demonstrating the vaginal cuff (arrows) of a posthysterectomy patient.

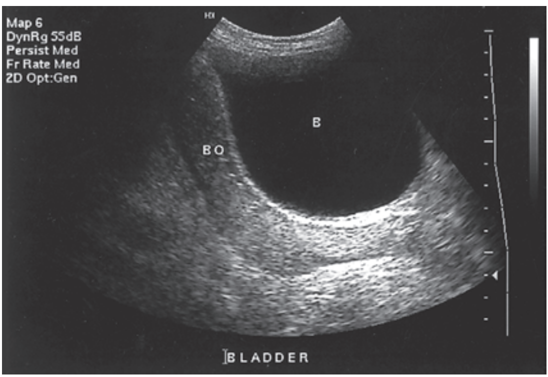


Figure 13-29 Bowel loop mimicking the uterus after hysterectomy. Longitudinal sonogram in a posthysterectomy patient demonstrating a bowel loop (BO) in the uterine space. Although this appearance can mimic a uterus, note that the endometrial echo is not demonstrated. Bladder (B).

Summary

Examination of the uterus can be performed transabdominally or transvaginally depending on the clinical indication and patient's body habitus. Regardless of the approach, a number of characteristics are to be noted during the examination. These include the following:

- Size measured in three dimensions (consider age and parity)
- Echogenicity of myometrium
- Uterine shape
- Orientation (anteverted, retroverted)
- Location (midline, deviated to the right or left)
- Borders (smooth or irregular)
- Location and echogenicity of masses
- Endometrial layer (size and echogenicity)
- Presence of fluid, masses, air, or foreign bodies within endometrial cavity

Chapter 14: The Ovaries and Fallopian Tubes (Adnexa)

CYNTHIA SILKOWSKI

Normal Sonography of the Ovaries

- Ovoid/almond shape
- Normally located anterior to internal iliac vessels (Figure 14-1A and B)
- Position can vary dependent on size and location of uterus and degree of bladder filling.
- Homogeneous midlevel echoes
- Immature follicles seen as multiple anechoic structures on ranging in size from 0.5–18 mm
- Mature follicle range in size from 20–25 mm at the time of ovulation (Figure 14-2A and B).
- Pelvic muscles and echogenic bowel loops may mimic normal ovaries (Figure 14-3).

Ovarian Mean Dimensions

- Prepubertal female (1 × 1 × 1 cm)
- Menstruating female (3 × 2 × 2 cm) (Figure 14-4)
- Postmenopausal female (2 × 2 × 1 cm or smaller)

Pathology

Ovarian Cyst (Simple)

- Round, anechoic, smooth-walled structure (Figure 14-5)
- Unilocular
- Posterior acoustic enhancement

Ovarian Cyst (Complex)

Meets the criteria for a cyst with any of the following internal appearance(s):

- Thin or thick septations (echogenic hair-like strands[s] within the cyst) (Figure 14-6)
- Multilocular compartments (cluster of cysts) (Figure 14-7)

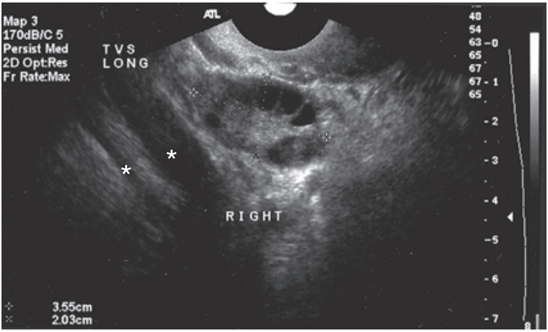


Figure 14-1A Ovary. Transvaginal sagittal image of the ovary (between caliper markers) situated anterior to the iliac vessels (*).

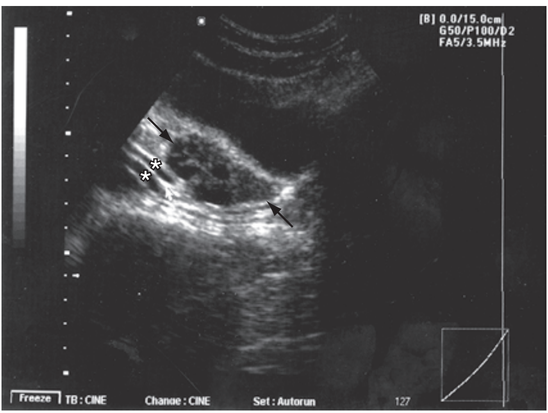


Figure 14-1B Ovary. Transabdominal sagittal image of the ovary (between arrows) situated anterior to the iliac vessels (*).

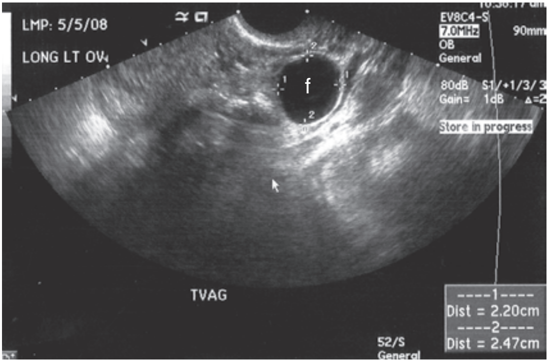


Figure 14-2A Dominant follicle. Transvaginal sagittal image of the ovary demonstrating an anechoic mature follicle (f).

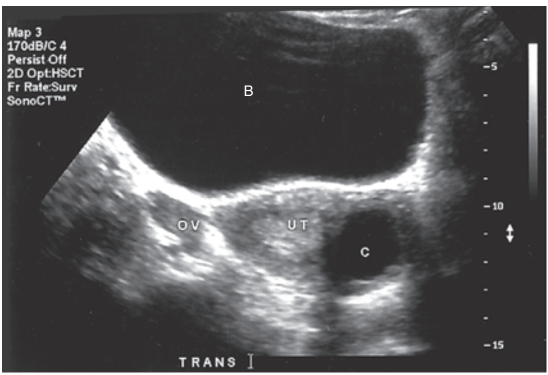


Figure 14-2B Dominant follicle. Transabdominal transverse image demonstrating the uterus (UT), right ovary (ov), and the left ovary with a mature follicle cyst (c). Urinary bladder (B).

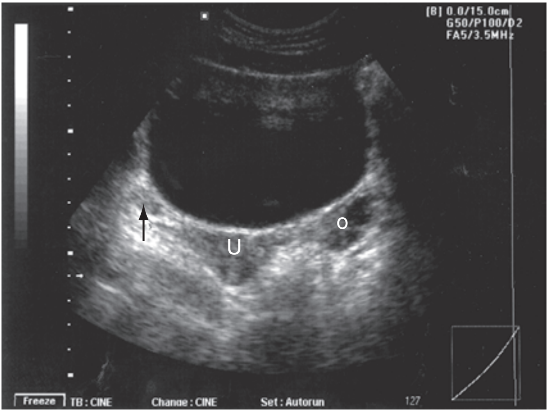


Figure 14-3 Obturator internus muscle. Transabdominal transverse image demonstrating the uterus (U), left ovary (o), and the right obturator internus muscle (arrow). Note the lack of anechoic follicles within the obturator internus muscle.

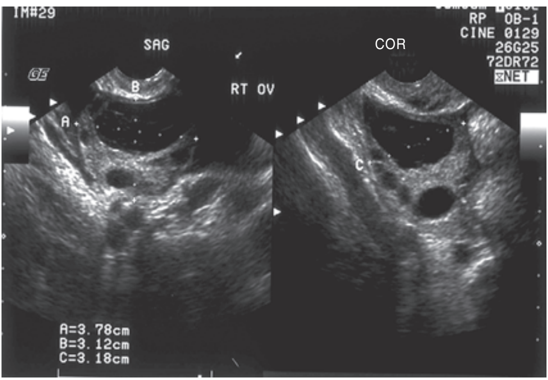


Figure 14-4 Ovarian measurements. Transvaginal sagittal and coronal images of the right ovary measuring the length, width, and A/P diameters.

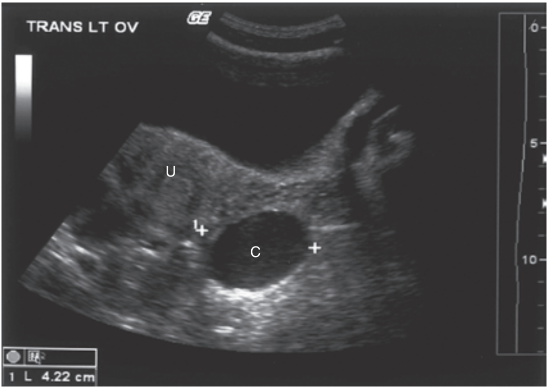


Figure 14-5 Simple ovarian cyst. Transabdominal transverse oblique image demonstrating an anechoic, unilocular, smooth-walled cyst (c) on left and uterus (u) on the right.

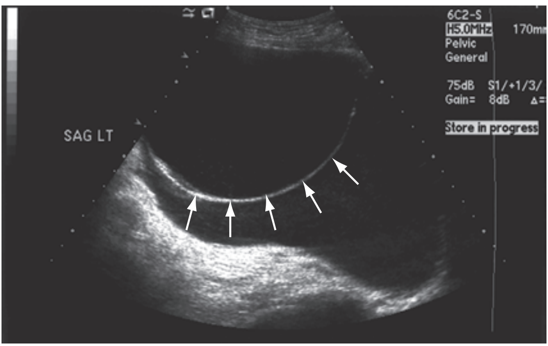


Figure 14-6 Complex ovarian cyst. Transabdominal sagittal image demonstrating a cyst containing a thin, echogenic, hair-like strand representing a septation (arrow heads) within a cyst.

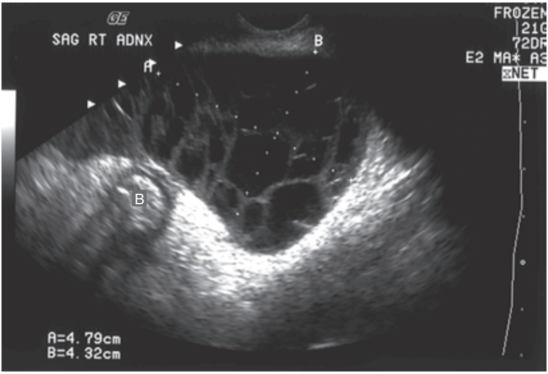


Figure 14-7 Complex ovarian cyst. Transabdominal sagittal image demonstrating a cyst with multiple septations and loculations. Note the solid mass-like appearance of the bowel (B) posterior to the cyst.

- Fluid–fluid layers (hyperechoic and hypoechoic layers within a cyst)
- May have reverberation artifact (low-level echoes on anterior aspect of cyst)
- Internal low-level echoes representing infection or hemorrhage

Hemorrhagic Cyst

Hemorrhagic cysts have a spectrum of sonographic appearances time dependent on clot hemolysis. These include the following:

- Cyst with fine level echoes (appearance more commonly related to endometriomas)
- Multiple septations (Figure 14-8A)
- Solid hyperechoic mass (acute hemorrhage) (Figure 14-8B)
- Cyst with solid component (hemorrhage on anterior or posterior portion of cyst as clot retracts) (Figure 14-8C and D)

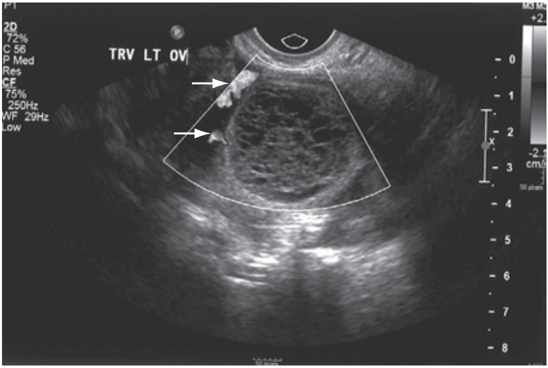


Figure 14-8A Hemorrhagic cysts with a spectrum of sonographic appearances. Transvaginal images. (A) Hemorrhagic cyst with reticular pattern of internal echoes and multiple septations. Color Doppler demonstrates vascularity (arrows) outside the mass.

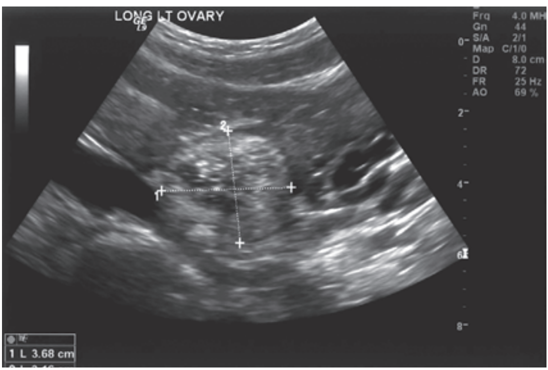


Figure 14-8B (B) Acute hemorrhagic cyst presenting as a solid hyperechoic mass with posterior enhancement. Acute hemorrhagic cyst mimicking a solid lesion.

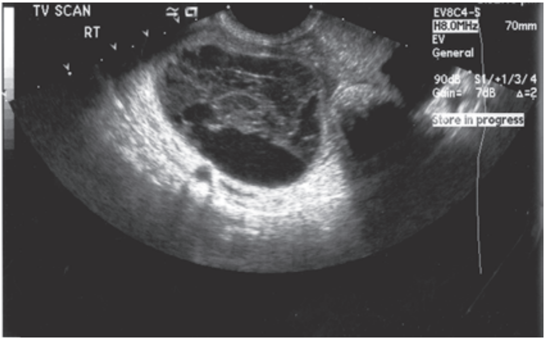


Figure 14-8C (C) Variations of clot retraction. (C) and (D) demonstrate cysts with echogenic hemorrhagic areas retracting toward the anterior surface.

- Absence of color flow Doppler within cyst (Figure 14-8D)
- Reduced posterior acoustic enhancement
- All of these appearances can mimic benign or malignant ovarian tumors or abscess.

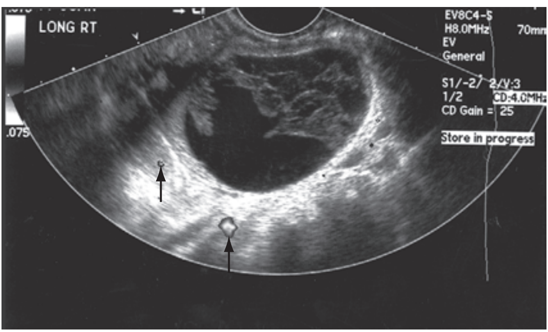


Figure 14-8D In (D), color Doppler demonstrates vascularity (arrows) outside the cyst. The lack of internal vascularity supports its benign nature.

Types of Functional Ovarian Cysts

<u>Follicular Cyst</u>

- Mature follicle that did not involute
- Generally greater than 25 mm and may become large (Figure 14-5)
- Usually unilateral

<u>Corpus Luteum Cyst</u>

- Associated with early pregnancy (10–12 weeks) (Figure 14-9)
- Usually involutes by 12 weeks gestation
- Unilateral
- Measures 4.0–6.0 cm

<u>Theca Luteal Cyst</u>

- Associated with hydatidiform mole
- Associated with ovarian hyperstimulation syndrome
- Largest functional cyst

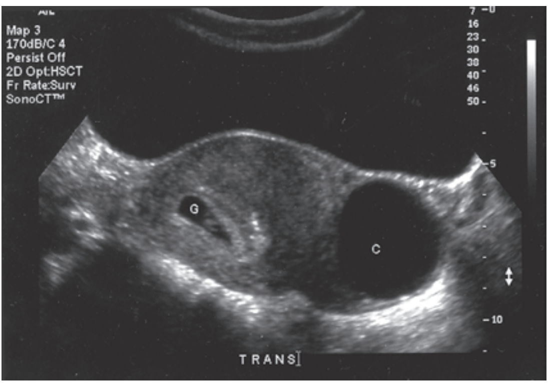


Figure 14-9 Corpus luteum cyst. Transabdominal transverse image demonstrating an intrauterine gestational sac (G) with a left-sided corpus luteum cyst (c).

- Bilateral and multilocular (Figure 14-10)
- Generally greater than 5 cm

Paraovarian Cyst

- Arise from broad ligament
- Can mimic ovarian cysts
- Size range from 4–8 cm
- Cyst seen separate from ovary may represent paraovarian cyst (Figure 14-11).

Benign Cystic Tumors

Serous Cystadenoma

- Most common ovarian epithelial neoplasm
- May be bilateral
- Unilocular, anechoic, thin-walled cystic mass (Figure 14-5)
- Can measure up to 30 cm
- May contain thin septations (< 3 mm)
- Occasionally may contain papillary projections

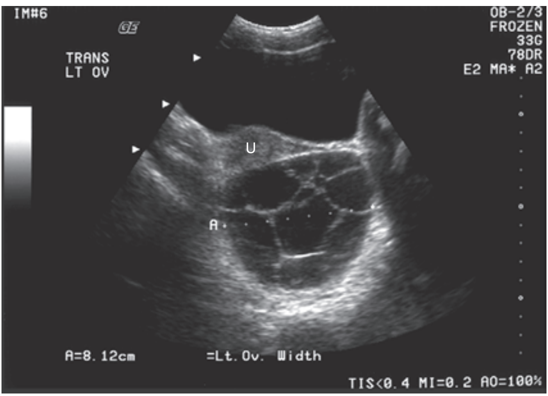


Figure 14-10 Theca luteal cyst. Transabdominal transverse image demonstrating a multilocular left-sided cyst. Uterus (U).

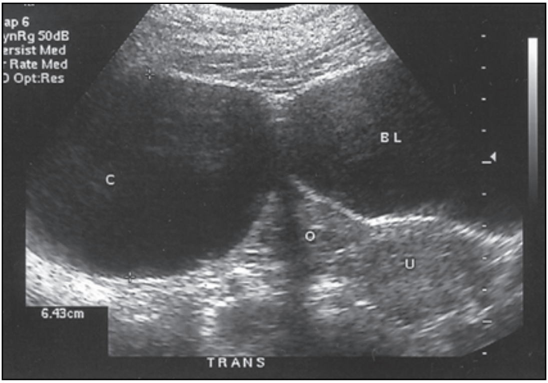


Figure 14-11 Paraovarian cyst. Transabdominal transverse oblique image demonstrating the urinary bladder (BL), uterus (U), right ovary (o), and cyst (c). The cyst is seen separate from the ovary.

<u>Mucinous Cystadenoma</u>

- Unilocular, anechoic, thin-walled cystic mass
- May contain low-level echoes
- Less frequently bilateral
- Can measure up to 30 cm

<u>Benign Cystic Teratoma (Dermoid Cyst)</u>

- Variable sonographic appearances (anechoic, complex, or hyperechoic) (Figure 14-12)
- Fat-fluid or hair-fluid levels (layering effect with two different echogenicities) (Figure 14-13)
- Cystic mass with round echogenic mass-like structures appearing to float within mass from hairballs (Figure 14-14)
- Hyperechoic mass with peripheral fluid (Figure 14-15A and B)
- Highly echogenic focal mass with sound attenuation obscuring the posterior component (Figure 14-16)

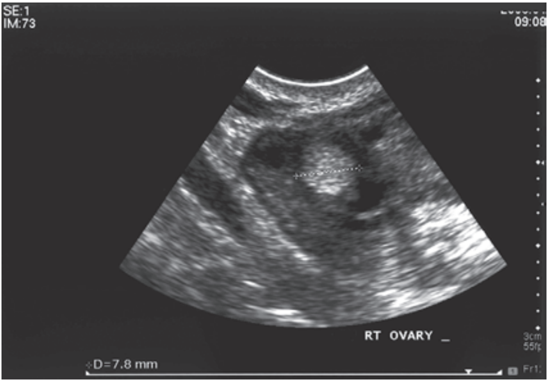


Figure 14-12 Dermoid cyst with a solid appearance. Transvaginal coronal image demonstrating a solid hyperechoic mass within the right ovary. Dermoids have a spectrum of sonographic appearances.

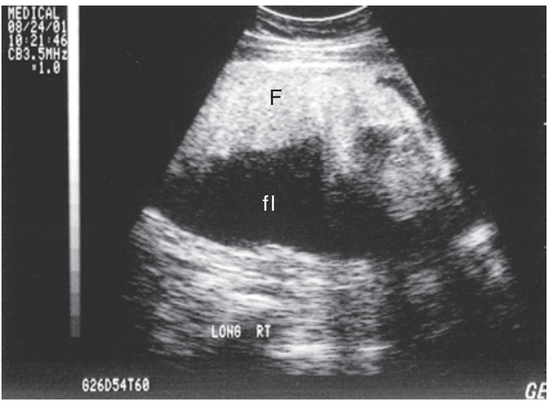


Figure 14-13 Dermoid cyst containing a fat–fluid level. Transabdominal sagittal image of the right adnexa demonstrating a large complex cystic mass with a fat–fluid level. Note the echogenic layer of fat (F) on the anterior aspect of the mass. Fluid (fl).

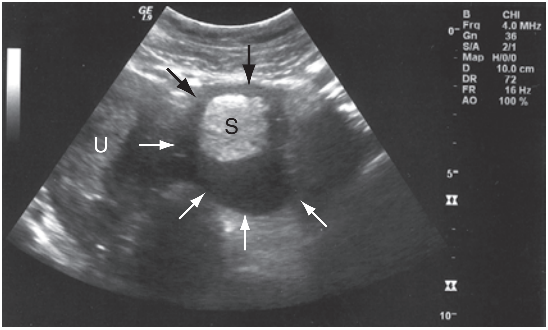


Figure 14-14 Dermoid cyst with solid component. Transvaginal coronal image demonstrating the uterus (U) on the right side and a complex mass with a solid (S) component on the left. The solid component appears to be floating within the anechoic mass (arrowheads) consistent with a hairball.

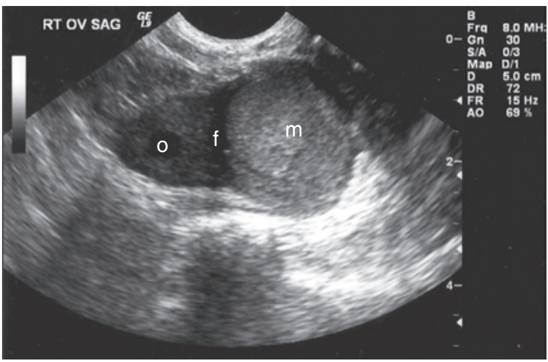


Figure 14-15A Dermoid cyst, solid appearing with peripheral fluid. (A) Transvaginal sagittal image of the right ovary (o) demonstrating a solid hyperechoic mass (m) with peripheral fluid (f). The acoustic enhancement posterior to the solid component supports its benign nature.

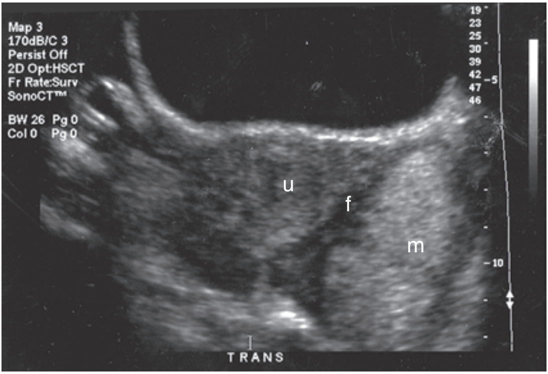


Figure 14-15B (B) Transabdominal transverse image demonstrating the uterus (u), a left-sided solid mass (m) with peripheral fluid (f). The appearance is similar to bowel. Lack of peristalsis confirms a mass.

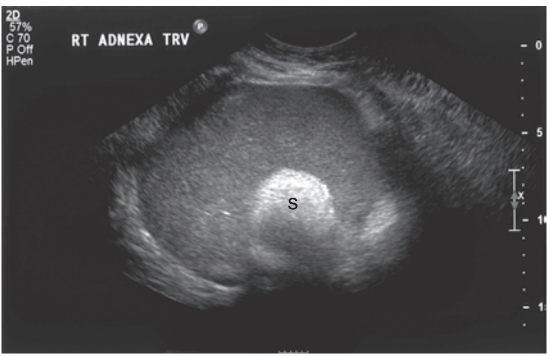


Figure 14-16 Dermoid cyst with solid component. Transabdominal transverse image demonstrating a complex mass filled with low-level echoes and a hyperechoic solid (s) area with posterior attenuation. Note the minimal amount of peripheral fluid surrounding part of the mass.

- Cystic mass with linear echogenic interfaces within (dermoid mesh)
- Predominantly cystic or solid mass with focal echogenic area(s) that shadow representing teeth, hair, bone, and/or fat (Figure 14-17)
- Dermoids commonly seen superior to uterus (Figure 14-18)
- Echogenic or anechoic bowel loops may mimic a dermoid or other complex adnexal masses (Figure 14-19A, B, and C).

Malignant Cystic Tumors

Serous and Mucinous Cystadenocarcinoma

- Large multilocular complex cystic masses (up to 30 cm) (Figure 14-20A and B)
- Thickened and irregular walls
- Thick internal septations (> 3 mm)
- Echogenic areas within mass

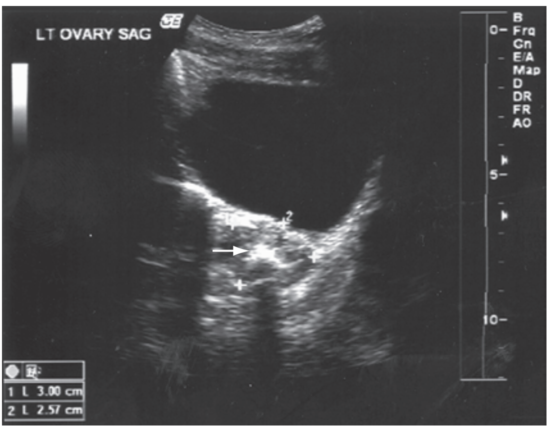


Figure 14-17 Dermoid with focal area with shadowing. Transabdominal sagittal image of a complex mass demonstrating an echogenic focal area (arrow) with posterior shadowing, which may represent teeth or bone.

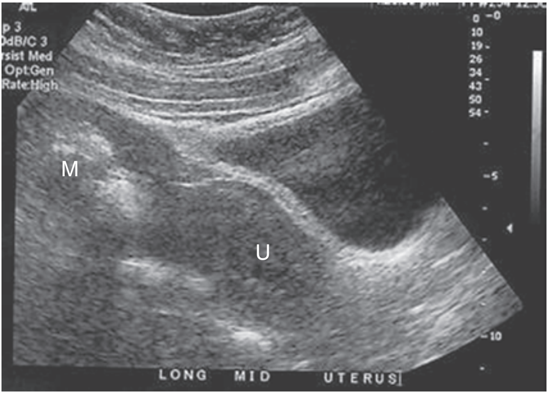


Figure 14-18 Dermoid located superior to uterus. Transabdominal sagittal image demonstrating a solid mass (M) with shadowing located superior to the uterus (U).

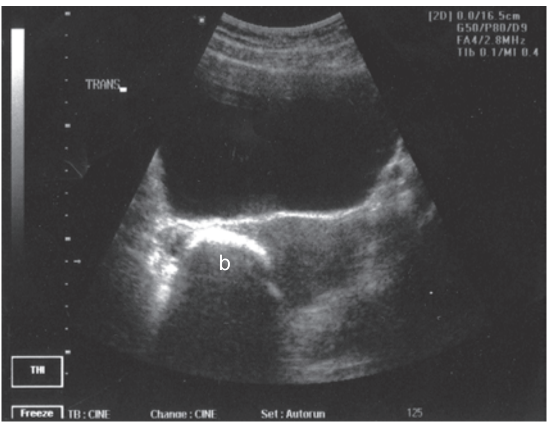


Figure 14-19A Bowel mimicking a dermoid. Transabdominal and transvaginal images of bowel (b) mimicking a dermoid.

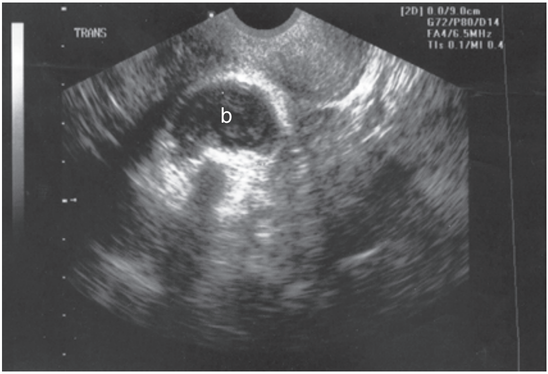


Figure 14-19B Bowel mimicking a dermoid. Transabdominal and transvaginal images of bowel (b) mimicking a dermoid.

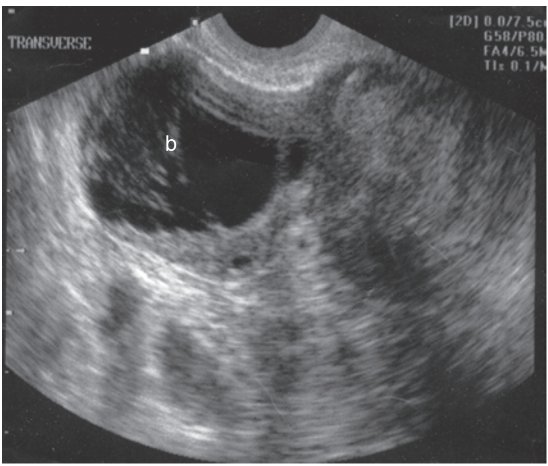


Figure 14-19C Bowel mimicking a complex adnexal mass. Transvaginal image demonstrating a bowel (b) appearing as a complex predominantly cystic mass.

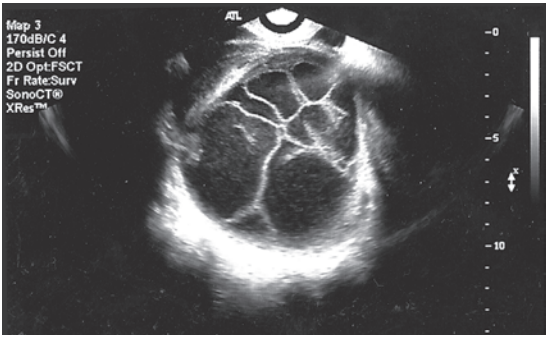


Figure 14-20A Cystadenocarcinoma. Transabdominal images of complex predominantly cystic mass containing thick septations and solid areas.

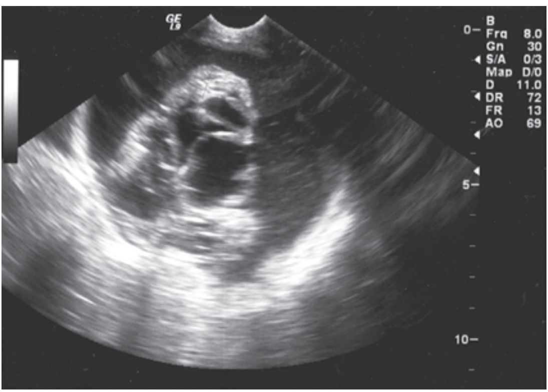


Figure 14-20B Cystadenocarcinoma.

- Doppler may demonstrate internal vascularity (Figure 14-21A and B)
- Associated findings include lymphadenopathy, ascites, and liver metastasis

Benign and Malignant Solid Ovarian Tumors

- Benign and malignant solid ovarian tumors are indistinguishable on sonography.
- Variable appearances (hypoechoic, echogenic, or hyperechoic mass)

Features that may be suggestive of malignancy include the following:

- Irregular borders
- Vascularity within the mass (Figure 14-22)
- May contain cystic areas within mass (representing necrotic changes)

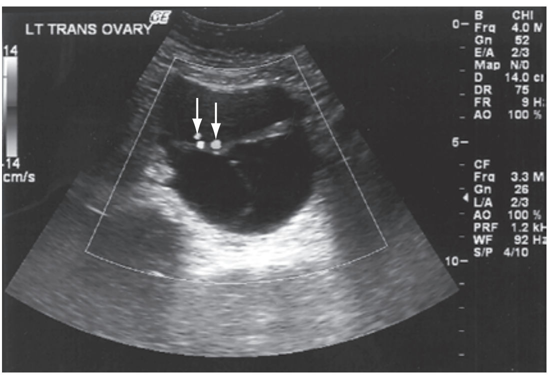


Figure 14-21A Cystadenocarcinoma. (A) Color Doppler demonstrating internal vascularity (arrows) within a complex mass (see color inserts).

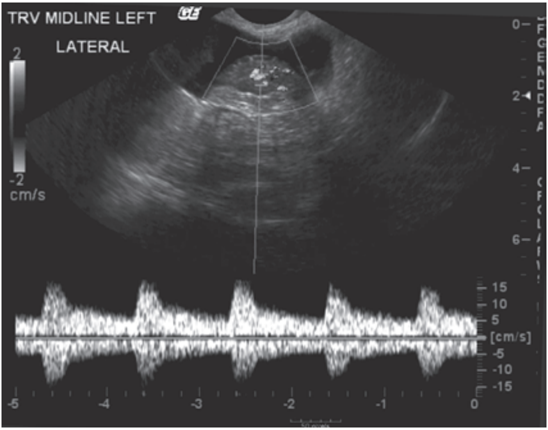


Figure 14-21B (B) Complex mass with color and spectral Doppler demonstrating internal vascularity. Both are more suggestive of a malignant process.

- Associated findings include lymphadenopathy, ascites, and liver metastasis.
- Solid ovarian masses adjacent to uterus may mimic a pedunculated fibroid.

Examples of benign and malignant solid ovarian tumors include the following:
- Brenner's tumor, dysgerminoma (Figure 14-23), germ cell tumors, thecoma (Figure 14-24), fibroma, yolk sac tumor, Krukenberg tumors (Figure 14-25), lymphoma, Sertoli-Leydig cell tumor

Ovarian Torsion

- Enlarged ovary
- Multiple cortical follicles may be present (Figure 14-26A and B).

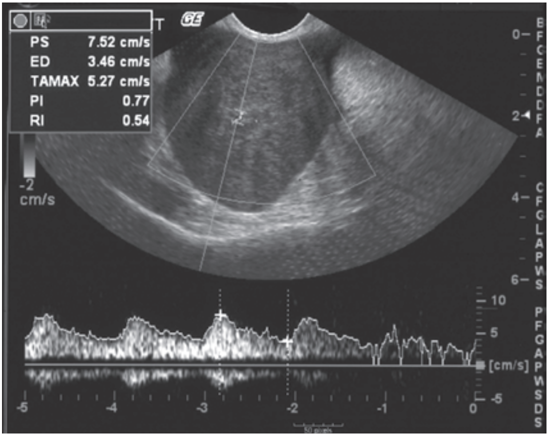


Figure 14-22 Mass with spectral Doppler tracing. Transabdominal sagittal image of a mass. Spectral Doppler tracing demonstrating vascularity within the mass is more suggestive of a malignant process.

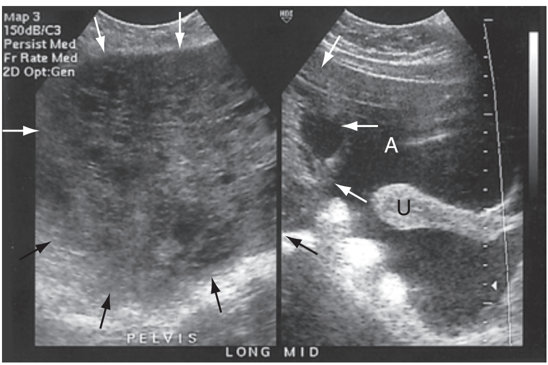


Figure 14-23 Dysgerminoma. Transabdominal sagittal split screen images demonstrating a large solid mass (within arrows) with anechoic necrotic areas. Pelvic ascites (A), uterus (U).

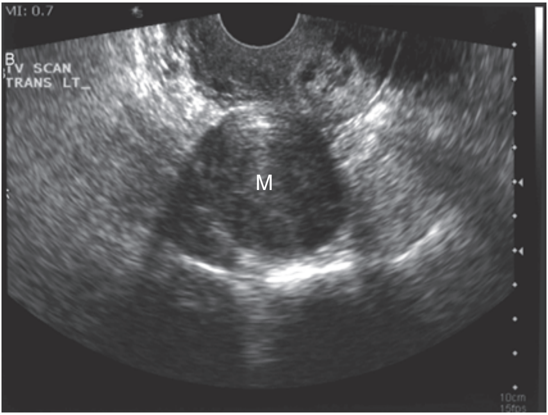


Figure 14-24 Thecoma. Transvaginal coronal image demonstrating a solid hypoechoic mass (M).

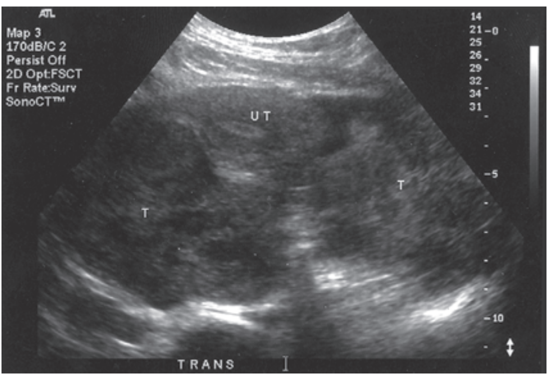


Figure 14-25 Krukenberg tumors. Transabdominal transverse image demonstrating the uterus (UT) and bilateral hypoechoic irregular masses (T).

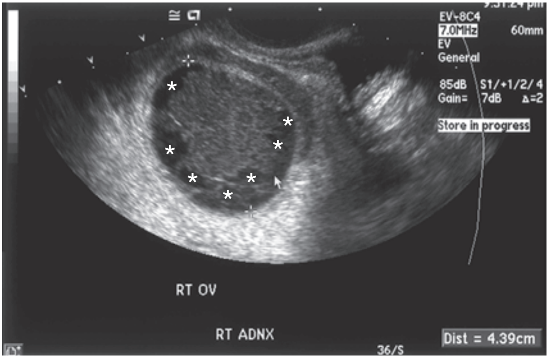


Figure 14-26A Ovarian torsion. Transvaginal sagittal image of an enlarged ovary with multiple cortical follicles (*).

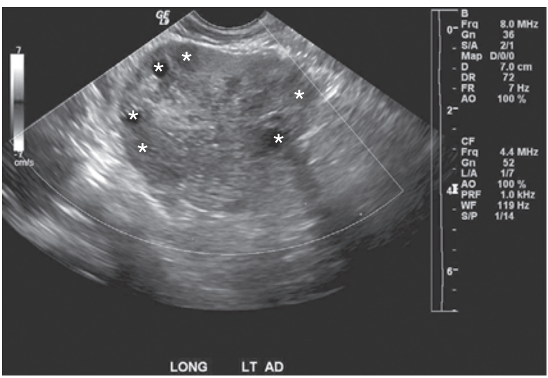


Figure 14-26B Ovarian torsion. Transvaginal sagittal image of an enlarged ovary with multiple cortical follicles (*) (see the color inserts).

- Twisted vascular pedicle may present as round hyperechoic structure with concentric hypoechoic stripes (target sign) or heterogeneous tubular structure.
- Adnexal mass separate from torsed ovary may be present.
- Color and spectral Doppler may or may not demonstrate flow within affected ovary dependent upon the duration and/or degree of vascular compromise (complete verses incomplete).
- Free fluid in posterior cul-de-sac (commonly seen)
- More commonly affects right ovary, therefore mimicking acute appendicitis

Fallopian Tubes

- Not visualized routinely but can be seen on occasions (Figure 14-27)

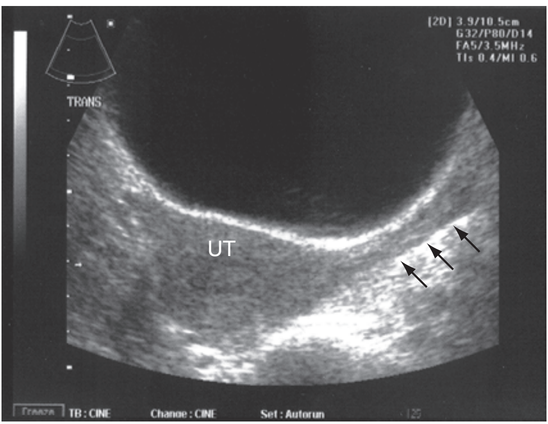


Figure 14-27 Fallopian tube. Transabdominal transverse image demonstrating the uterus (UT) and left fallopian tube/broad ligament (arrows).

- Easier to visualize if surrounded by fluid (ascites) or in the presence of some pathologies such as hydrosalpinx or pyosalpinx (to be discussed)

Pelvic Inflammatory Disease

Endometritis

- Seen as small collection of fluid within endometrial cavity (Figure 14-28)
- May have thickened endometrial cavity
- May see hyperechoic air with shadowing in endometrial cavity (due to gas-producing organisms) (Figure 14-29)

Hydrosalpinx/Pyosalpinx

- Sometimes difficult to differentiate between hydrosalpinx and pyosalpinx on sonography
- Hydrosalpinx seen as dilated anechoic tubular-shaped structure(s) without internal echoes

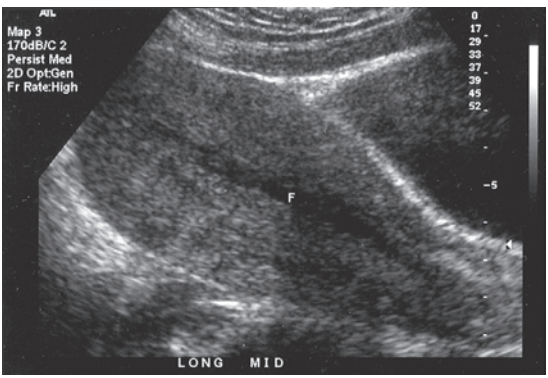


Figure 14-28 Endometritis presenting with fluid. Transabdominal sagittal image demonstrating an enlarged uterus containing a minimal amount of fluid (F) within the uterine cavity.

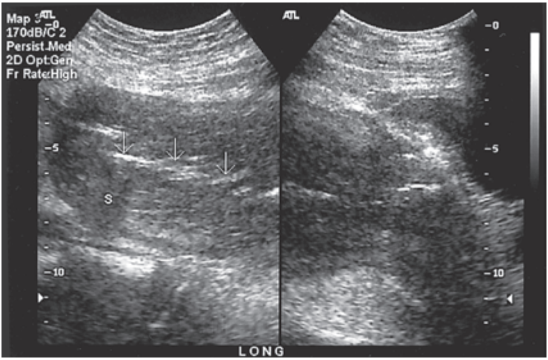


Figure 14-29 **Endometritis with air.** Transabdominal sagittal split-screen image of an enlarged uterus with echogenic air (arrows) seen within the uterine cavity and posterior shadow (s).

- Pyosalpinx seen as dilated anechoic tubular-shaped structure(s) with internal echoes (Figure 14-30A–C)
- Posterior acoustic enhancement
- These findings can be unilateral or bilateral.

Tubo-Ovarian Abscess

- Complex multiloculated adnexal mass(es)
- Irregular shape (Figure 14-31A and B)
- Indistinct borders
- Scattered internal echoes
- Septations
- Posterior acoustic enhancement
- Fluid–debris level or echoes (representing gas) within the mass

Endometriosis

- Functioning endometrial tissue outside uterus
- Types include diffuse or local

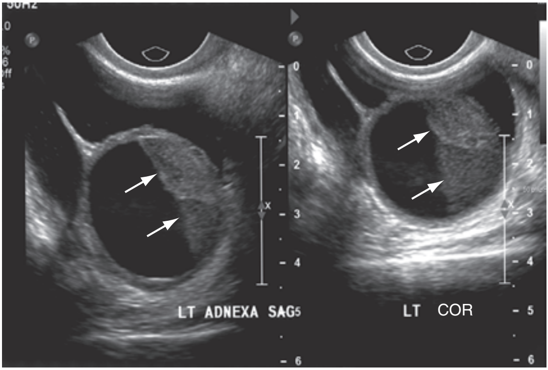


Figure 14-30A Pyosalpinx. (A) Transvaginal sagittal and coronal images of a left tortuous fallopian tube dilated with fluid and echogenic material (arrows) representing pus.

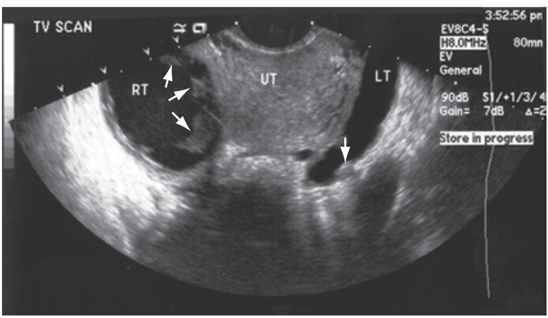


Figure 14-30B (B) Transvaginal coronal image demonstrating the uterus (UT), right (RT) and left (LT) dilated fluid-filled tubes with echogenic material (arrows) representing pus.

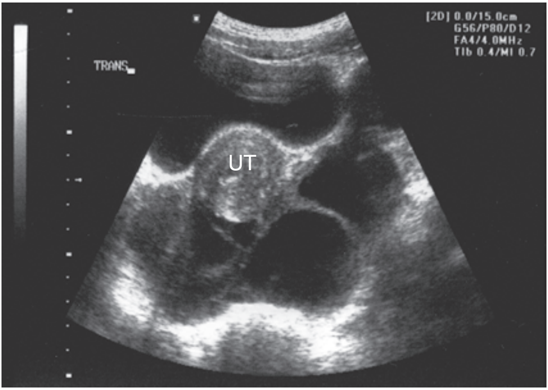


Figure 14-30C (C) Transabdominal transverse image of the pelvis demonstrating the uterus (UT) and bilaterally dilated tubular anechoic structures with echogenic material.

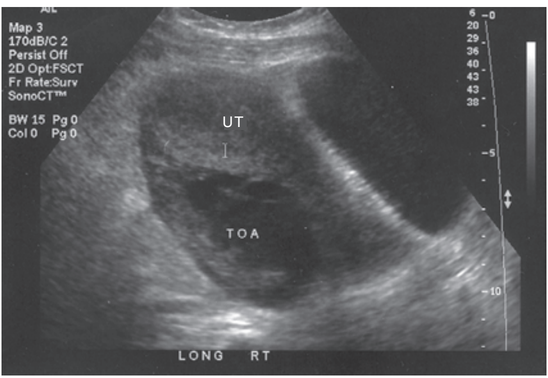


Figure 14-31A **Tubo-ovarian abscess.** Transabdominal images. (A) Sagittal image.

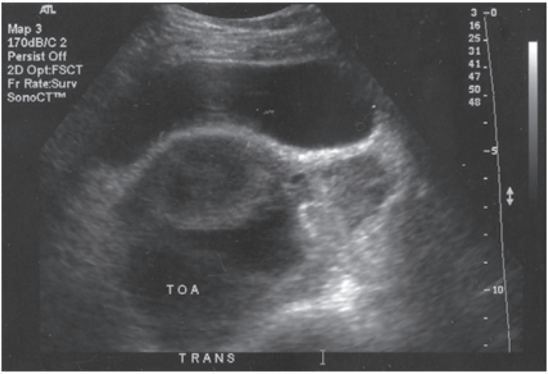


Figure 14-31B (B) Transverse image. Both images demonstrate a complex collection that represents a tubo-ovarian abscess (TOA) posterior to the uterus (UT).

- Diffuse form rarely diagnosed (small implants difficult to visualize)

Endometrioma (Chocolate Cyst)

- Localized form of endometriosis
- Well-defined discrete predominantly cystic mass
- Unilocular or multilocular
- Internal diffuse homogeneous low-level echoes (Figure 14-32)
- Frequently multiple
- Fluid–fluid level may be seen
- Hyperechoic linear foci within wall of the cyst
- Appearance similar to hemorrhagic cyst

Nongynecological Pelvic Masses

The following are some entities which may commonly mimic a gynecological mass on ultrasound:

- Pelvic kidney (Figure 6-7)
- Abscesses (Figure 14-33)

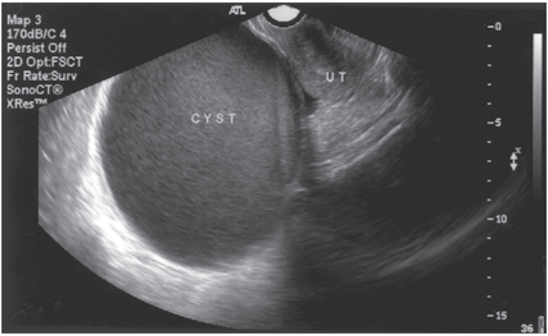


Figure 14-32 Endometrioma. Transvaginal coronal image of a large mass filled with fine low-level homogeneous echoes (CYST) consistent with an endometrioma. Note the acoustic enhancement posterior to the mass. Uterus (UT).

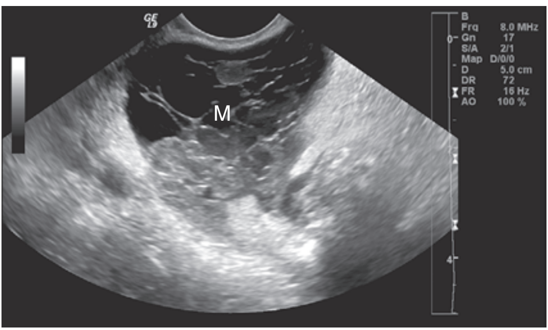


Figure 14-33 Pelvic abscess. Transvaginal coronal image of a complex mass (M) in a postoperative patient. This appearance can mimic a pelvic mass such as a cystadenocarcinoma.

- Retroperitoneal masses
- Obstructed urinary bladder
- Enlarged lymph nodes
- Dilated ureter

Summary

The ovaries can be evaluated using transabdominal or transvaginal imaging. Transvaginal probes are of higher frequency, which generally results in better resolution of the ovaries; however, the examiner must be careful not to mistake pelvic structures, such as muscles or echogenic bowel loops, for normal ovaries. Attention to the following characteristics is therefore important to note when routinely evaluating the ovaries:

- Size (measure in 3 dimensions)
- Location (relative to the uterus and iliac vessels)
- Echogenicity (isoechoic to uterus)
- Presence of follicles

Characteristics of Adnexal Masses on Sonography

The diagnosis of an adnexal mass can be difficult and challenging. Neoplasms, abscesses, and hemorrhagic masses may have similar sonographic appearances. Attention to the following ultrasound characteristics together with clinical correlation will help with formulating a differential diagnosis:

- Location (relative to uterus and ovaries)
- Size (measure in three dimensions)
- Echogenicity (hyperechoic, hypoechoic, anechoic)
- Homogeneity (homogeneous or inhomogeneous)
- Borders (smooth or irregular)
- Shape(round, oval, tubular)
- Posterior acoustic enhancement or sound attenuation
- Presence of shadowing

- Vascularity (presence of flow within structure)
- Presence of peristalsis or changes in size or shape (seen with bowel)
- Compressibility (seen with bowel)
- Displacement of pelvic organs, structures, or vessels
- Indentation of urinary bladder (to distinguish mass from bowel)
- Fixation of mass on postvoid images (lack of movement)
- Associated findings (presence of free fluid or lymphadenopathy)

Chapter 15: First Trimester Normal and Abnormal Pregnancy

CHARLES ODWIN

As discussed earlier in Chapter 13, sonographic imaging of the pelvis can be performed transabdominally or transvaginally. In early pregnancy, transvaginal sonography can image fetal structures 1 week earlier than the transabdominal approach. Moreover, transvaginal imaging is better suited for evaluating patients with bleeding in early pregnancy, particularly when an ectopic pregnancy is suspected.

This section describes normal sonographic findings seen in first trimester pregnancy followed by sonography of early pregnancy complications commonly seen in the emergency setting.

Sonographic Visualization of Normal Early Pregnancy

Week 4

- First sonographic evidence of pregnancy
- Round or oval shaped fluid-filled anechoic sac (Figure 15-1)
- Yolk sac and embryo not visualized
- Thick echogenic circumferential ring of echoes around gestational sac represents chorio-decidua (trophoblastic, chorionic, and decidual tissues) (Figure 15-2)
- Implanted in uterine cavity near fundus
- Gestational sac measures approximately 3 to 5 mm and grows approximately 1 mm per day
- Intragestational sac measurements performed to determine gestational age at 4 to 5 weeks (Figure 15-3)
- Serum beta human chorionic gonadotropin (hCG) is approximately 1,000 to 1,500 mIU/mL (discriminatory zone)

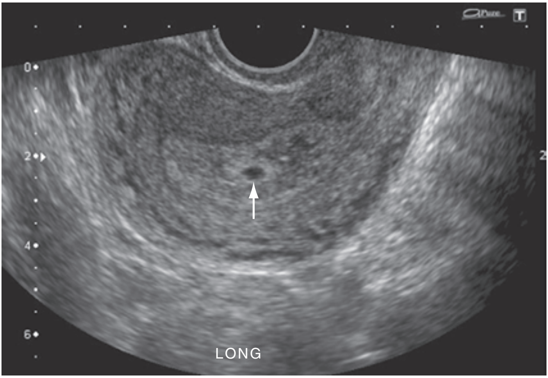


Figure 15-1 Gestational sac at 4 weeks. Transvaginal sonogram with arrow pointing to an early, anechoic intrauterine gestational sac at 4 weeks.

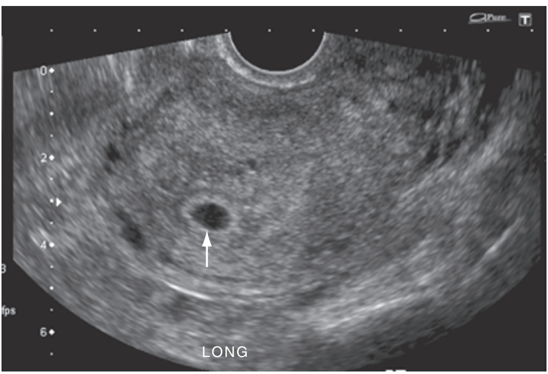


Figure 15-2 Chorio-decidua. A transvaginal sonogram with arrow pointing to a thick echogenic circumferential ring of echoes around anechoic gestational sac. This represents a collection of embryological tissues called chorio-decidua.

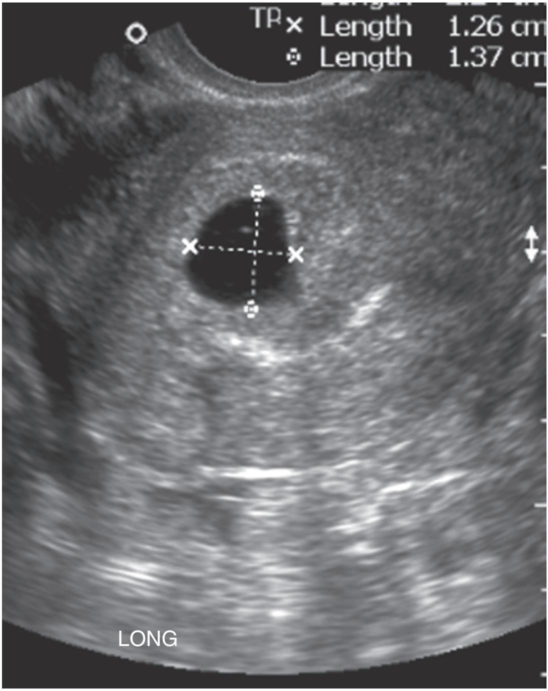


Figure 15-3 Gestational sac measurements. Transvaginal sonogram with calipers demonstrating measurements of the gestational sac size.

Week 5

- Yolk sac first visualized and usually measures less than 6 mm in size (Figure 15-4)
- Appears as round anechoic structure
- Normally seen when gestational sac measures more than 10 mm
- Double decidual sac sign present (echoes from interface between decidua capsularis and decidua parietalis)

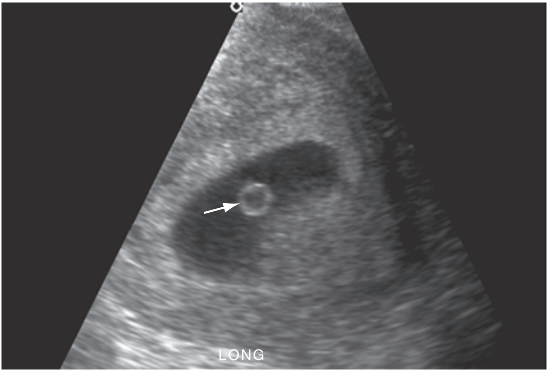


Figure 15-4 Secondary yolk sac. Transvaginal view with arrow pointing to the anechoic yolk sac, which is first seen at approximately 5 weeks of gestation.

- Thin echogenic dividing membrane may be seen with twin gestation.

Week 6

- Echogenic embryo seen abutting yolk sac (Figure 15-5)
- Crown-rump length (CRL) measurement used for assessment of gestational age (Figure 15-6).
- CRL can be obtained between 6- to 12-weeks gestation.
- Embryo's cardiac motion seen, with possible earlier depiction at 5.5 weeks with higher frequency transvaginal probe
- Embryo's heart motion can be documented using M-mode with normal heart rate between 90 to 140 beats per minute (Figure 15-7).
- Anechoic or complex corpus luteum cyst may be seen in adnexa.

Week 7

- Yolk sac larger than embryo

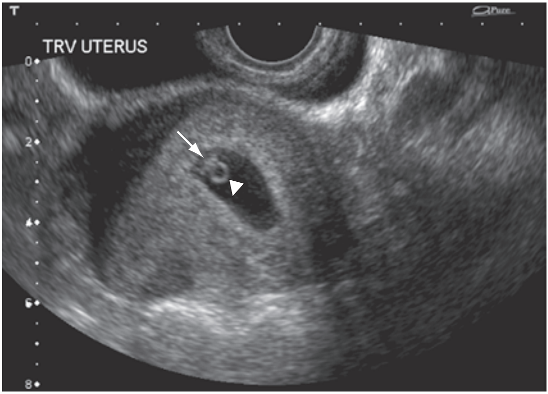


Figure 15-5 Embryo. Arrow points to an early embryo seen on a transvaginal view. The embryo is smaller than the adjacent yolk sac (arrowhead).

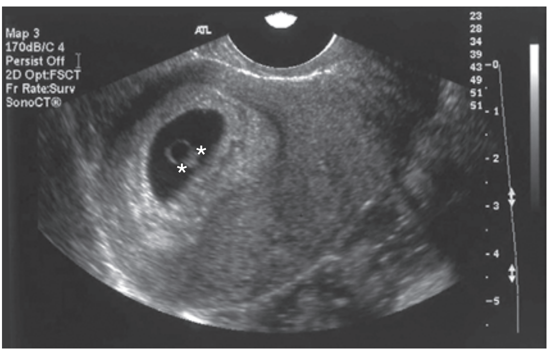


Figure 15-6 Crown rump length. Transvaginal image with calipers measuring the crown rump length for assessment of gestational age in the first trimester.

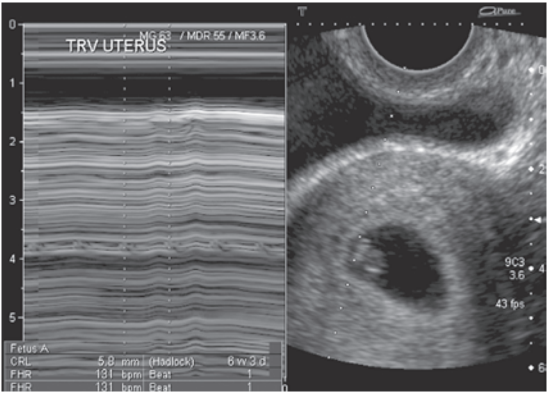


Figure 15-7 Embryonic heart rate. M-mode is being used to measure fetal heart rate. In this example, the heart rate is 131 beats per minute.

Week 8

- Embryo with echogenic mass at base of umbilical cord represents normal physiologic herniation of midgut (Figure 15-8).
- Should not mistake the above for pathologies such as omphalocele or gastroschesis
- Echogenic and linear yolk stalk also called vitelline duct (Figure 15-9)
- Normally developing primary brain vesicle (rhombencephalon) seen as cystic area within head (Figure 15-10)
- Embryo's limb buds seen (Figure 15-11)

Week 9

- Hyperechoic amniotic membrane seen dividing amniotic cavity from chorionic cavity (extraembryonic coelom) (Figure 15-12)
- Yolk sac seen in chorionic cavity

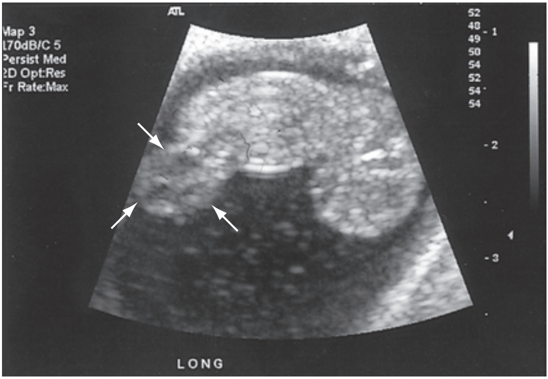


Figure 15-8 Physiologic herniation of bowel. Echogenic mass (between arrows) represents normal herniation of bowel seen on transabdominal ultrasound. This finding should not be mistaken for abdominal wall defects such as omphalocele or gastroschisis.

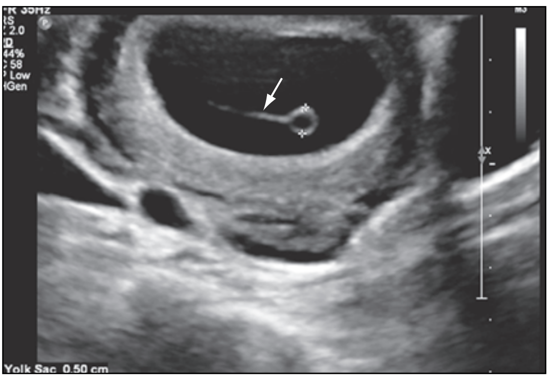


Figure 15-9 Yolk stalk. Transvaginal sonogram with arrow pointing to yolk stalk, which is echogenic and linear. The yolk sac is also seen (between calipers).

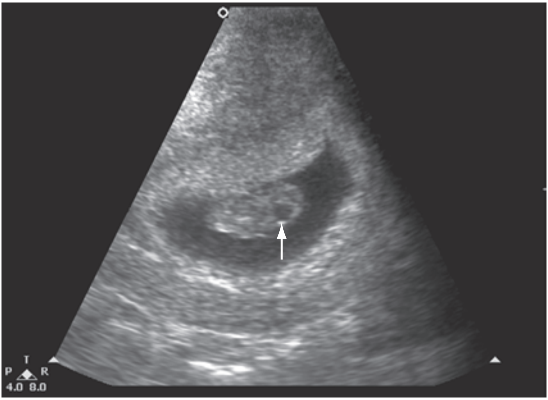


Figure 15-10 Primary brain vesicle. Transabdominal sonogram with arrow pointing to normally developing primary brain vesicle. This anechoic area should not be mistaken for hydrocephalus.

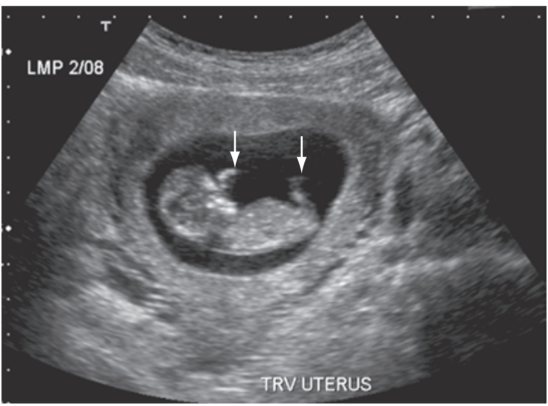


Figure 15-11 Fetal limb buds. Transabdominal scan with arrows pointing to the embryo's limb buds in upper and lower extremities.

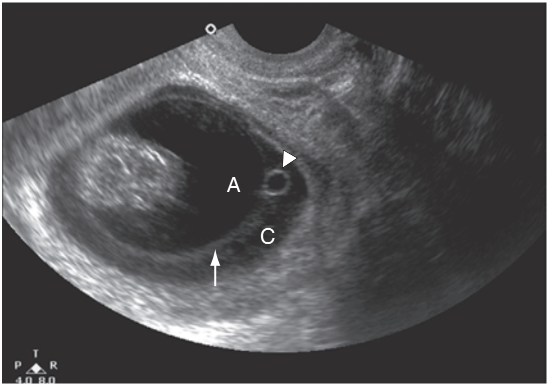


Figure 15-12 Amniotic membrane. Transvaginal image showing echogenic amniotic membrane (arrow) separating amniotic cavity (A) from chorionic cavity (C). Note the presence of the yolk sac (arrow head) in chorionic cavity.

Week 10

- Embryo now referred to as a fetus
- Echogenic early placenta seen (Figure 15-13)
- Echogenic umbilical cord seen inserting into fetal abdomen (Figure 15-14)

Week 11

- Hyperechoic fetal spine and cranial bones seen (Figure15-15)
- Echogenic choroid plexus seen within the fetal brain (Figure 15-16)

Week 12

- Amnion and chorion begin to fuse.
- Yolk sac no longer seen in most cases
- Corpus luteum cyst begins to regress.
- Increased curvature of fetus results in less reliable CRL measurement.

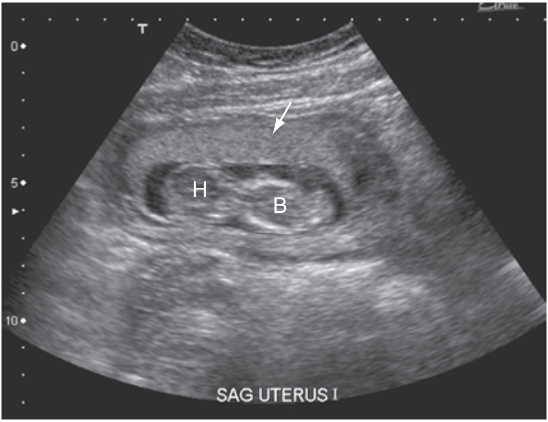


Figure 15-13 Early placenta. Transabdominal view demonstrating an echogenic early placenta (arrow) on the anterior wall of the uterus. H—fetal head, and B—fetal body.

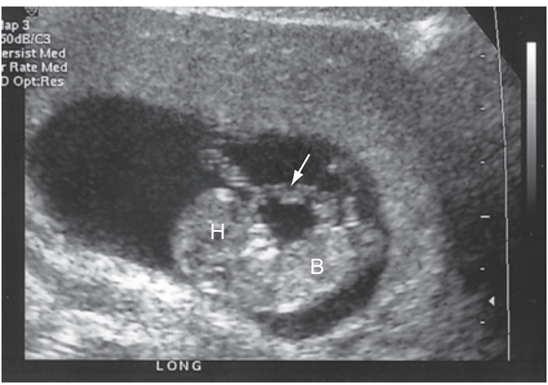


Figure 15-14 Umbilical cord. Transabdominal view demonstrates the umbilical cord (arrow) inserting into the fetal abdomen. H—fetal head, and B—fetal body.

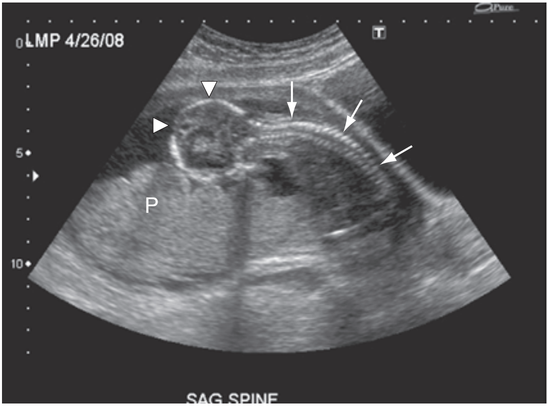


Figure 15-15 Fetal spine and cranial bones. Transabdominal sonogram with fetus in breech position. The echogenic fetal spine (arrows) and fetal skull (arrow heads) are demonstrated. P—posterior placenta.

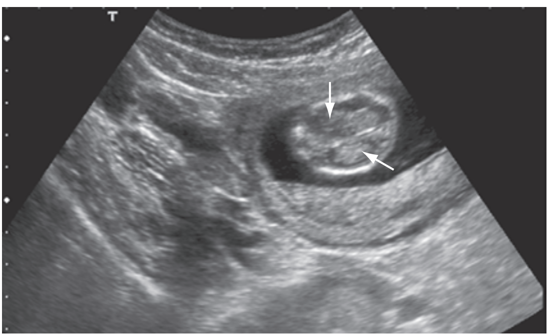


Figure 15-16 Choroid plexus. Transabdominal image shows echogenic choroid plexus (arrows) within the fetal brain.

Multiple Pregnancies

When multiple pregnancies are encountered, it is important to document the following information:

- Number of gestational sacs
- Number of yolk sacs and membranes
- Number of embryos
- M-mode documentation of cardiac motion of the embryos

Dichorionic–Diamniotic Twins

- Two separate gestational sacs (Figure 15-17)
- Individual trophoblastic tissue
- Thick echogenic dividing membrane
- Each gestational sac has its own individual yolk sac, amniotic membrane, and embryo

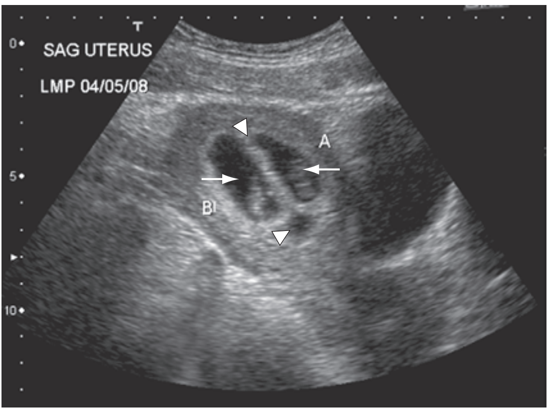


Figure 15-17 Twin gestation with dividing membrane. Transabdominal sonogram of twin gestation with embryos (long arrows) in separate sacs, which is divided by echogenic membrane (arrow head). A small subchorionic hemorrhage (short arrow) is demonstrated inferior to the gestational sac.

Monochorionic–Diamniotic Twins

- Single gestational sac (Figure 15-18)
- Individual trophoblastic tissue
- Thin echogenic dividing membrane
- Two yolk sacs, two amnions, and two embryos

Abnormal First Trimester Pregnancy

Subchorionic Hemorrhage

- Implantation bleed behind the chorion
- May vary in size and echogenicity (Figure 15-19A and B)

Blighted Ovum (Anembryonic Gestational Sac)

- Gestational sac without a yolk sac or embryo (Figure 15-20)
- Abnormally small or large empty gestational sac
- Irregular or decreased thickness of chorio-decidua
- Gestational sac fails to grow on weekly exams.

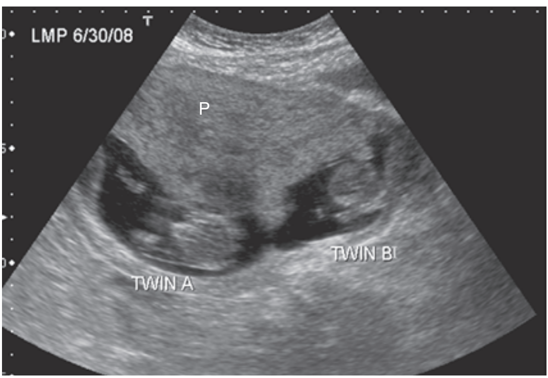
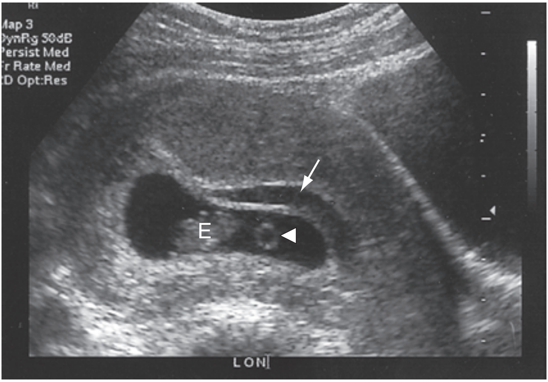


Figure 15-18 Monochorionic–diamniotic twins. Transabdominal view showing twin fetus in the same gestational sac. A single placenta (P) is seen anteriorly.



(A)

(B)

Figure 15-19A & B Subchorionic hemorrhage. Transabdominal (A) shows a small anechoic collection of blood (arrow) anterior and inferior to the gestational sac, which contains an embryo (E) and yolk sac (small arrow). (B), also transabdominal, shows a much larger collection (H), which is echogenic and located inferior to the gestational sac containing a yolk sac (arrow).

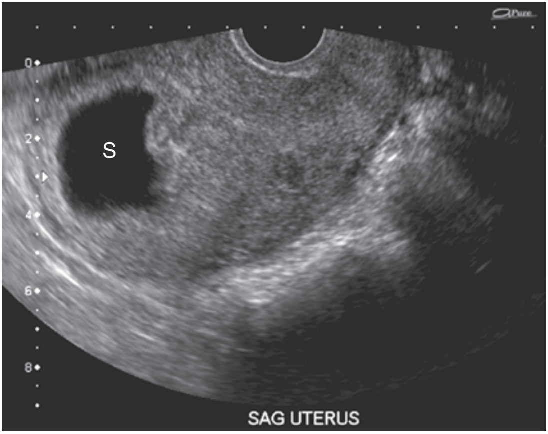


Figure 15-20 Blighted ovum. Transvaginal image shows a large and irregular gestational sac (S). It does not contain a yolk sac or an embryo.

Missed Abortion (Retention of Dead Embryo)

- Embryo small compared with gestational sac size (Figure 15-21)
- Gestational sac with irregular echoes representing non-viable embryo
- Must document absence of cardiac activities on M-mode tracing

Incomplete Abortion (Retained Products of Conception)

- Disorganized echoes in endometrial cavity (Figure 15-22)
- Bulging cervix with disorganized echoes in endocervix (cervical phase of impending abortion) (Figure 15-23)
- Serum beta hCG decline is greater than half when compared with previous beta hCG levels

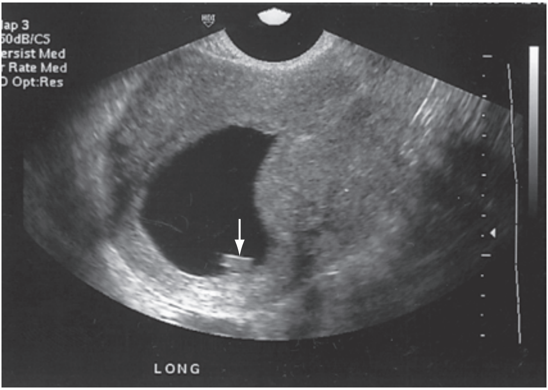


Figure 15-21 Missed abortion. Transvaginal image shows a small embryo (arrow) within a disproportionately large gestational sac. No fetal movement or cardiac activity was demonstrated.

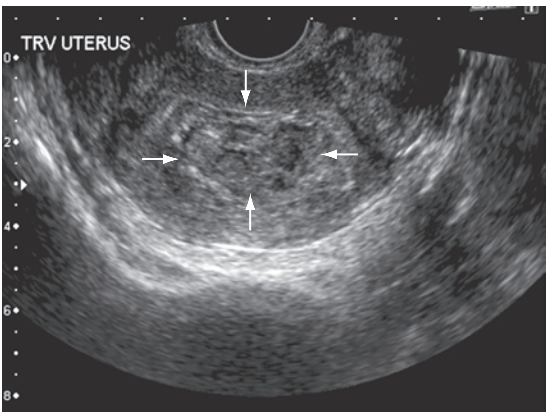


Figure 15-22 Incomplete abortion. Transvaginal view demonstrates disorganized echoes (between arrows) within the endometrial cavity. This is consistent with an incomplete abortion.

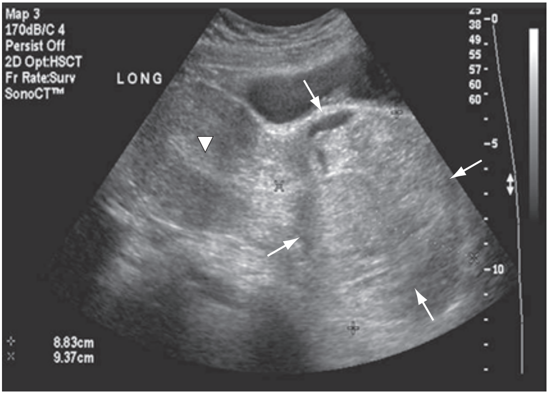


Figure 15-23 Incomplete abortion. Transabdominal view shows a large echogenic mass with a fluid area anteriorly contained within the cervix (between arrows). This represents the cervical phase of an abortion in progress in a patient with heavy vaginal bleeding. The normal endometrial stripe (arrowhead) indicates an empty uterine cavity.

- Difficult to distinguish retained products from retained blood clots except in cases of small retained fetal bone fragments

Complete Abortion

- Thin echogenic endometrial stripe (less than 10 mm)
- No evidence of retained products (Figure 15-24)
- Rapid decline of serum beta hCG levels

Hydatidiform Mole (H- Mole)

- Echogenic mass with small cystic areas (vesicles) within uterine cavity (Figure 15-25A)
- Increased color Doppler flow within mass (Figure 15-25B)
- Size of vesicles increases with gestational age (Figure 15-26).

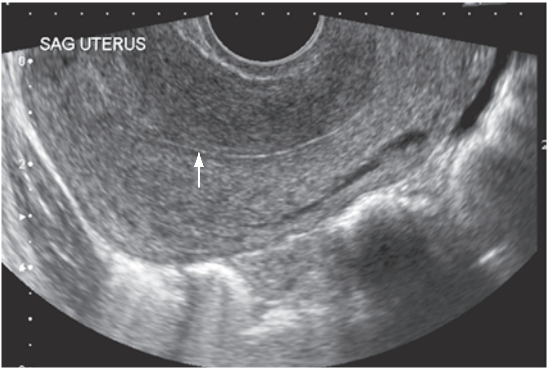
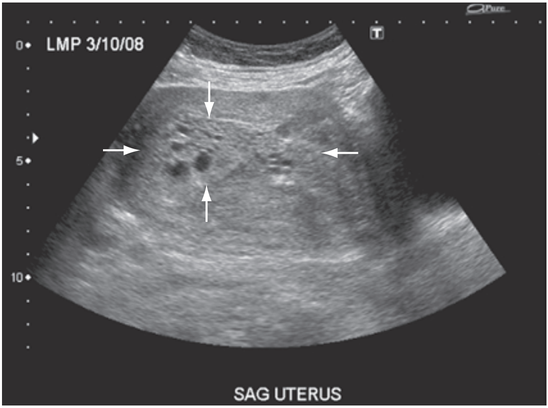


Figure 15-24 **Complete abortion.** Transvaginal image in a patient with a history of spontaneous abortion a day earlier. The normal endometrial stripe (arrow) indicates that there is no evidence of an intrauterine pregnancy or retained products of conception.

- May mimic missed abortion, incomplete abortion, blighted ovum, degenerating fibroids or choriocarcinoma
- Associated with theca lutein cyst which appears multiloculated (Figure 15-27)
- Fetus and molar transformation of placenta seen in partial mole.

Ectopic Pregnancy

This describes any pregnancy outside of the endometrial cavity. The sonographic appearance of an ectopic pregnancy varies depending on its location and whether it is ruptured or unruptured. Both transabdominal and transvaginal imaging should be performed to avoid misdiagnosis caused by technical error. Unruptured ectopic pregnancies should be measured for size of gestational sac or embryo. M-mode tracing is also performed to document fetal heart monitor when detected. It is also important to correlate sonographic findings with beta hCG levels.



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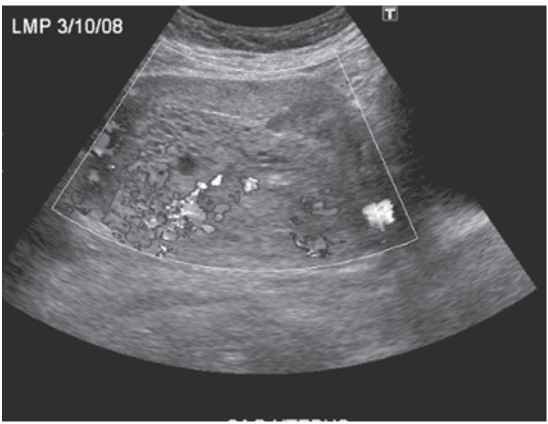


(B)

Figure 15-25A & B Hydatidiform mole. (A) is a trans-abdominal view showing endometrial cavity containing echogenic tissue with multiple small cystic areas (between arrows). (B) demonstrates increased color Doppler flow within the uterine cavity (see color inserts). This patient was 12-weeks pregnant on clinical exam.

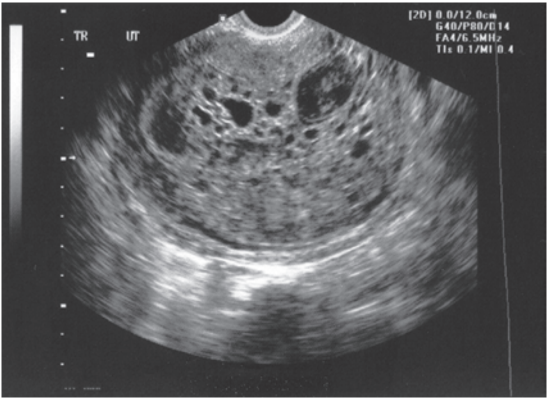


Figure 15-26 Hydatidiform mole. Transvaginal image of hydatidiform mole with multiple anechoic vesicles of various sizes within uterine cavity. This patient was 16-weeks pregnant by dates.

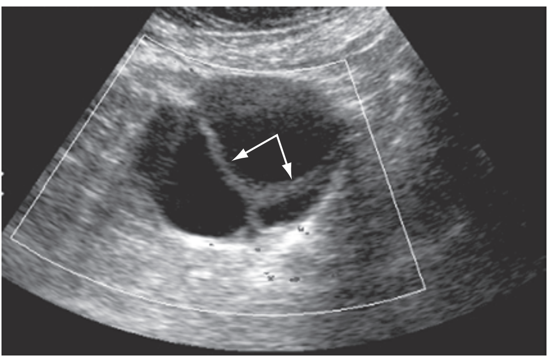


Figure 15-27 Theca lutein cyst. Transabdominal image in a patient with a hydatidiform mole demonstrates a theca lutein cyst with internal septations (arrows). There was no flow on color Doppler exam (see color inserts).

Sites of Ectopic Pregnancy

- Ampullary segment of the fallopian tubal most common
- Other sites include cornual (interstitial), cervical, ovarian, broad ligament, and abdominal
- Ectopic pregnancy may also co-exist with normal intrauterine pregnancy (heterotopic).

Intrauterine Findings in Ectopic Pregnancy

- Echogenic endometrial stripe (normal or thickened)
- Intrauterine sac-like structure represents blood (pseudogestational sac) (Figure 15-28).
- Pseudogestational sac lacks surrounding echogenic decidual reaction and trophoblastic flow.
- Lacks yolk sac or embryo and sac does not increase in size on weekly exams

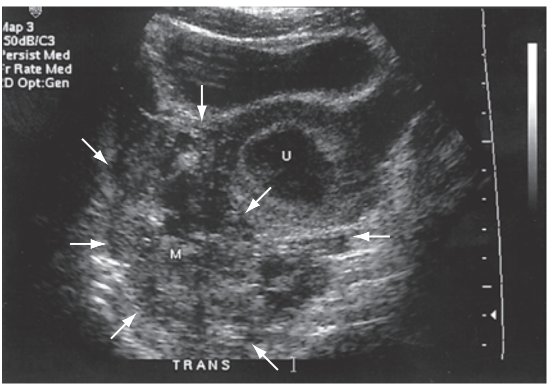


Figure 15-28 Pseudogestational sac. Transabdominal image in a patient with an ectopic pregnancy shows a large pseudogestational sac within the uterus (U). The ectopic pregnancy presented as a large, complex adnexal mass (M between arrows).

Extrauterine Findings in Unruptured Ectopic Pregnancy

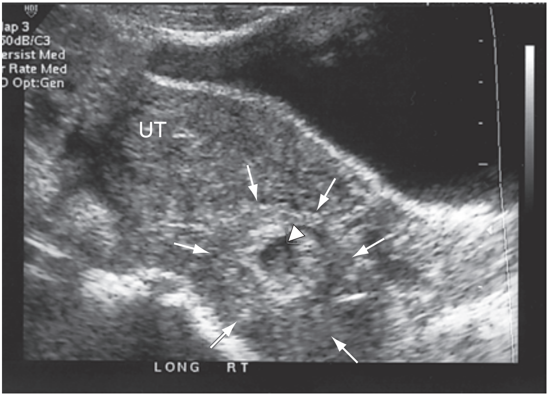
- Extrauterine gestational sac with or without fetal embryo or yolk sac (cardiac motion may be present)
- Extrauterine gestational sac with thickened echogenic ring (adnexal ring) (Figure 15-29A and B)
- Increased color Doppler flow around adnexal mass (ring of fire appearance) (Figure 15-30)
- Thick wall ovarian cyst may mimic adnexal ring and also demonstrate presence of color flow (Figure 15-31).

Extrauterine Findings in Leaking or Ruptured Ectopic Pregnancy

- Complex or solid adnexal mass
- Echogenic free fluid (hemoperitoneum) in the cul-de-sac, adnexa paracolic gutters, and/or Morrison's pouch (Figure 15-32A and B)
- Fluid is gravity dependent and shifts in location when patient is turned.
- Rebound tenderness may be detected on transabdominal scanning.

Cornual Ectopic Pregnancy

- Eccentric position of gestational sac (Figure 15-33)
- Thin (less than 5 mm) or absent myometrium laterally surrounding gestational sac
- Pregnancy in bicornuate uterus will appear eccentric and could mimic a cornual pregnancy (Figure 15-34).
- Overdistended urinary bladder and fibroid uterus may cause normal sac to appear eccentric due to extrinsic pressure(Figures 15 -35 and 5-36).
- Cornual ectopic ruptures late (10 to 16 weeks) and causes profuse bleeding.
- Serum beta hCG may double in 48 hours like a normal IUP.



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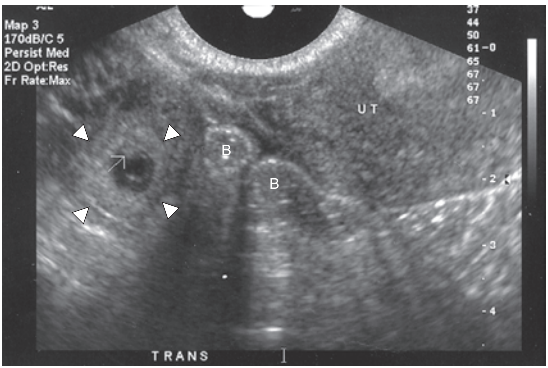


(B)

Figure 15-29A & B Adnexal ring in ectopic pregnancy. (A) A transabdominal longitudinal view that shows an extrauterine gestational sac (between arrows) posterior to the uterus (UT). An early embryo (arrow head) is seen within the sac. (B) is a transverse endovaginal view in a different patient that shows an adnexal ring (between arrow heads) with an embryo (arrow) and a yolk sac. The uterus (UT) is seen medial to the gestational sac. B—bowel loops.

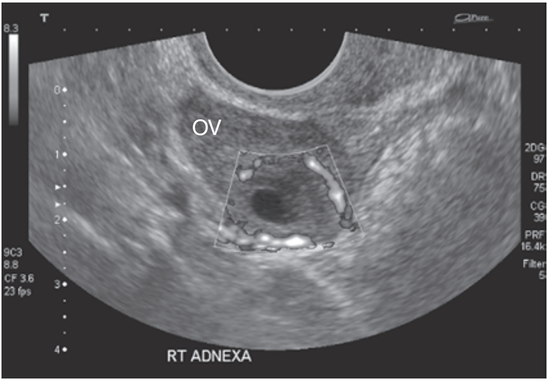


Figure 15-30 Ring of fire in ectopic pregnancy. Transvaginal view showing an ectopic pregnancy with increased vascularity on color Doppler (see color inserts). Ovarian tissue (OV) is seen anteriorly.

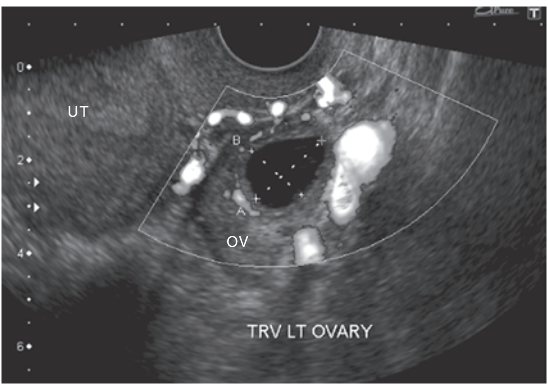
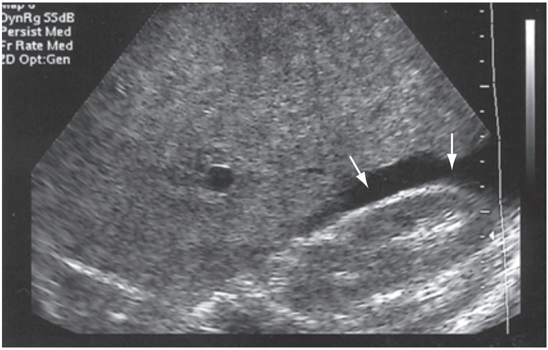
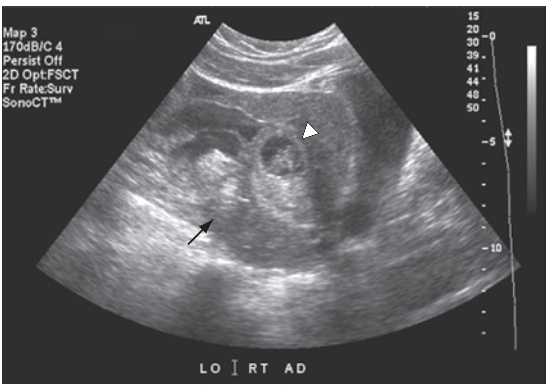


Figure 15-31 Ovarian cyst mimicking adnexal ring in ectopic pregnancy. Endovaginal view demonstrates an ovarian cyst (within calipers) with color Doppler flow partially around the ovary (OV). This appearance can mimic an adnexal ring seen in ectopic pregnancy (see color inserts). UT—uterus.



(A)



(B)

Figure 15-32A & B Hemoperitoneum. The transabdominal view in (A) shows anechoic free fluid in Morrison's pouch (arrows). (B), echogenic fluid (arrow) is seen posterior to an ectopic pregnancy (arrowhead).

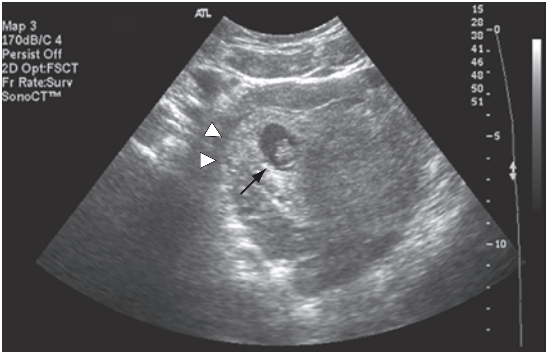


Figure 15-33 Cornual ectopic pregnancy. Transabdominal sonogram with gestational sac (arrow) located eccentrically within uterine cavity. Note the thin layer of myometrial tissue on the lateral aspect of gestational sac (arrowheads).

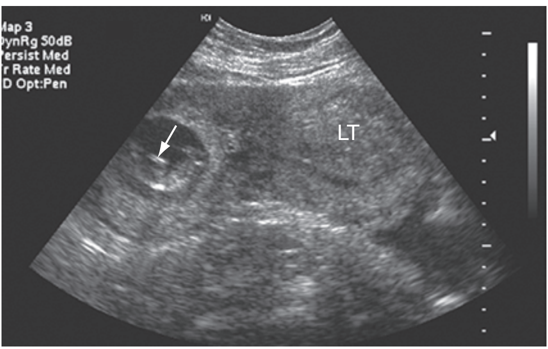


Figure 15-34 Bicornuate uterus mimicking cornual ectopic pregnancy. Transverse transabdominal view shows bicornuate uterus with a pregnancy in right horn (arrow). The left horn (LT) is seen adjacent. There is myometrial tissue surrounding the gestational sac.

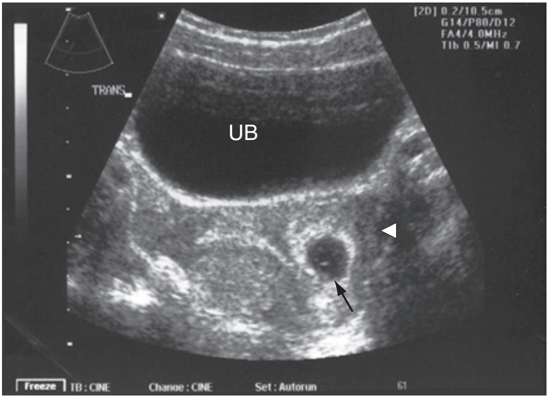


Figure 15-35 Overdistended urinary bladder producing eccentric gestational sac. Transabdominal image shows overfilled bladder (UB) displacing gestational sac (arrow). Note the presence of myometrium (arrowhead) around the sac, which indicates an intrauterine location.

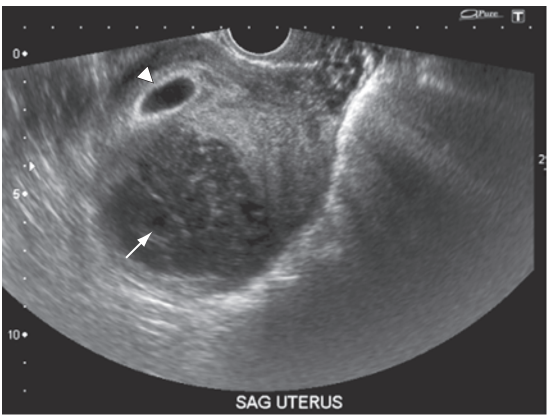


Figure 15-36 Fibroid uterus causing eccentric gestational sac. The transvaginal sagittal view demonstrates large hypoechoic fibroid (arrow) anteriorly displacing the anechoic gestational sac (arrowhead).

Cervical Ectopic Pregnancy

- Gestational sac seen in cervical region
- Gestational sac may have yolk sac or live embryo with cardiac activity (Figure 15-37).
- Presence of peritrophoblastic color Doppler flow around gestational sac
- Uterus and cervix may have an hourglass (figure eight) appearance.
- Cervical phase of impending abortion may mimic cervical ectopic pregnancy.
- If rupture occurs at cervical isthmus, appearance can mimic an adnexal ectopic.
- Absence of hemoperitoneum when rupture occurs at cervical isthmus
- Rupture results in massive bleeding.
- Pregnancy continues to develop, rather than abort.

Abdominal Pregnancy

- Empty uterine cavity with normal or slightly enlarged uterus

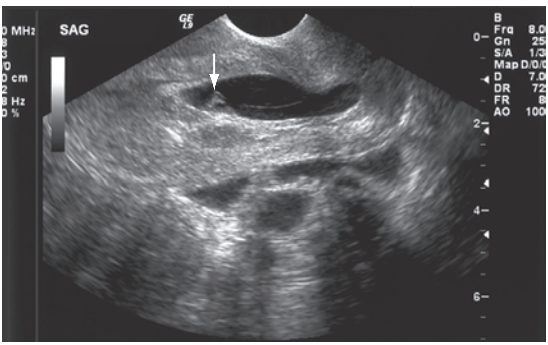


Figure 15-37 Cervical ectopic pregnancy. Sagittal transvaginal view demonstrates a gestational sac in the cervical region. An early embryo (arrow) is identified within the gestational sac.

- Pregnancy in peritoneal cavity
- Bowel with peristalsis in close proximity to fetus
- May resemble intrauterine pregnancy if uterus not seen
- Myometrium not seen around gestational sac, embryo, or fetus
- May develop to maturity
- Asymptomatic in most cases
- Echogenic placenta may implant on bowel or peritoneum with sonographic evidence of bowel peristalsis behind placenta.

Heterotopic Pregnancy

- Intrauterine pregnancy with co-existing extrauterine pregnancy (Figure 15-38)
- Sonographic appearance dependent on gestational age and whether extrauterine gestation is ruptured or unruptured

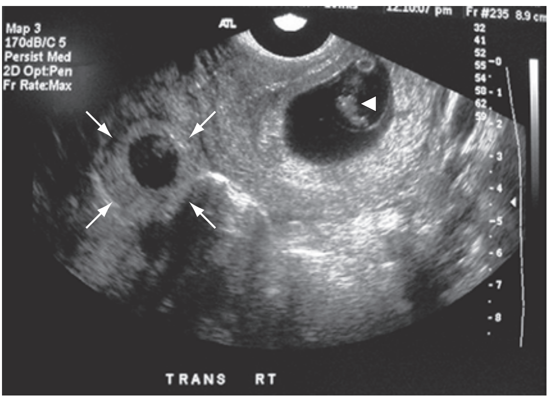


Figure 15-38 Heterotopic pregnancy. A transvaginal transverse view with an intrauterine gestation containing an embryo (arrowhead). An extrauterine pregnancy (between arrows) is also demonstrated.

- Serum beta hCG may double in 48 hours like a normal IUP.

Masses Seen in First Trimester Pregnancy

Ovarian Masses

- Adnexal masses such as ovarian cysts and dermoids are often detected in patients with an intrauterine pregnancy (see Chapter 13).
- Large adnexal masses require transabdominal imaging for better documentation of technical details.

Uterine masses

- Fibroids of various sizes and locations can be encountered (Chapter 13).
- May rapidly enlarge during pregnancy
- Focal myometrium contractions (FMC) may mimic fibroid uterus.
- FMC contractions do not distort uterine contour and disappear after 20 to 30 minutes.
- Uterus with large fibroid is better evaluated with transabdominal sonography.

Summary

1. First-trimester sonography can be performed transabdominal or transvaginal. Transvaginal imaging has better resolution and can visualize fetal structures earlier. The following information should be documented on routine exam in first trimester pregnancy: intrauterine location of pregnancy, cardia motion on M-mode tracing, measurement of gestational sac, yolk sac, or embryo for estimation of gestational age, number of gestational sacs/embryos, and the adnexal structures.
2. A number of sonographic findings may indicate that a pregnancy will have a poor outcome. Some of these include the following: abnormal gestational sac shape or size, lack of embryo in a

large gestational sac, and low position of a gestational sac within uterus.

3. Ectopic pregnancy has a number of sonographic findings which can be seen both intrauterine and/or extrauterine. These findings are dependent on the location of the ectopic pregnancy, the gestational age, and the presence of hemorrhage due to rupture. Sonographic findings must be correlated with serum beta hCG levels.

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Index

A

Abdominal aorta
- aneurysm, 85
- fusiform aneurysm of, *89*
- normal sonographic anatomy, 84
- saccular aneurysm of, *89*

Abdominal mass, documenting sonographic characteristics with, 187

Abdominal organs, evaluating, 186

Abdominal pathologies, sonographic appearances with, 186–187

Abdominal pregnancy, 274–275

Abdominal trauma. *See* Blunt abdominal trauma

Abortion
- complete, 263, *264*
- incomplete, 261, *262,* 263, *263*
- missed, 261, *262*

Abscesses. *See also* Cysts
- appendiceal, *132*
- calf, 179
- drainage, 185
- gynecological mass mimicked by, 243
- liver, 35, 38, *39,* 40
- pelvic, *244*
- splenic, 140, *140, 141*
- testicular and scrotal, 163, *165*
- tubo-ovarian, 240, *242, 243*

Acalculous cholecystitis, 60

Accessory spleen, *137*

Acoustic enhancement artifact, 5, 7, *7*

Acute calculous cholecystitis, 56, *57*

Acute pyelonephritis, *117*

Acute testicular torsion
- torsion greater than 4 hours, 160
- torsion less than 4 hours, 160

Adenocarcinoma
- pancreatic, 76, *76,* 78, *81*
  - in head of pancreas, *80*
  - in tail of pancreas, *80*

Adenomyomatosis, 56, *57*

Adenomyosis, 202–203
- diffuse, 202–203, *203*
- nodular, 203

Adnexal masses
- complex, bowel mimicking, *231*
- first trimester pregnancy and, 276
- sonographic characteristics of, 245–246

Adnexal ring
- in ectopic pregnancy, *269*
  - ovarian cyst mimicking, *270*

Adrenal myelolipoma, renal mass mimicked by, *107*

Adult polycystic kidney disease
- early stage, 100, *101*
- late stage, 100

Air, in endometrial cavity, 214

Air-filled bowel loops
- gallstones and, 9
- mimicking of gallstones and, 47, *53*

Amebic abscess, 38, 40, *40*

Amniotic membrane, *255*

Anechoic, *2,* 24
- defined, 1
- distended urinary bladder anterior to uterus, *2*

Anechoic gallbladder, segments of, 47

Anembryonic gestational sac, 259
Aneurysm, abdominal aorta, 85
Angiomyolipoma, 42, 100, *102*
Anteverted uterus, 193, *194,* 214
Aorta
  coronal view of, *87*
  inferior vena cava *vs.,* on sonography, 84–85
  longitudinal view of, *87*
  normal, branches of, *87–88*
  transverse view of, *86*
Aortic dissection, *90*
Aortic graft, *91*
Appendiceal abscess, *132*
Appendicitis
  appendix wall measurement, 131, *131*
  with fecalith, *132*
Appendix, normal, *130*
Appendix testis
  isoechoic to testis, 157, *159*
  torsion of, 161
Ascites
  endometrial carcinoma and, 205
  fluid collection and, 183
  malignant, *184*
  ovarian carcinoma and, *207*
  pancreatic, 76, *78*
Atrophy, spleen, 136
Attenuation, abdominal masses and, 187
Attenuation artifact, 7, *8*
Audible Doppler systems, 18

B

Baker's cyst (popliteal fossa cyst), 179, *180*
Benign cortical renal cysts, *98*
Benign cystic teratoma (dermoid cyst), 225, *226, 227, 228, 229,* 229, *230*
Benign neoplasms, renal, 100, 103
  angiomyolipoma, 100, *102*
  lipomas, 103
  oncocytoma, 103, *103*
Benign tumors
  bladder, 122
  bowel, 133
  ovarian, 233, 234
Bicornuate uterus, 195, *196*
Bilateral hydrocele, *175*
Bile, tumefactive, *55*
Bile ducts. *See also* Gallbladder, 64–70
  biliary pathology, 64, 66, 68
    cholangiocarcinoma, 68
    choledochal cysts, 68
    choledocholithiasis (common bile duct stones), 66, *68*
    extrahepatic biliary obstruction, 64, 66
    intrahepatic biliary obstruction, 66
    pneumobilia (air in biliary tree), 68
  normal sonographic anatomy, 64, *65*
Biliary tree, air in, 68, *70*
Biopsy, mass, 185
Bladder diverticulum, 122, 125, *126*
Bladder tumor, enlarged prostate mimicking, *124*
Bladder wall, thickening of, *128*
Blighted ovum, 259, *261*
Blunt abdominal trauma, 147–156
  complications of, seen on sonography, 147
  sonographic findings in, 147–156
    diffuse organ injury, 147
    FAST scan, 148, 151

hematomas, 147–148, *149, 150, 151, 152, 153*
Body
of epididymis, 157
of pancreas, 71
Borders
abdominal masses and, 187
abdominal organ evaluation and, 186
adnexal masses and, 245
uterine, 214
Bowel
dermoid cysts mimicked by, *230, 231*
gallstones mimicked by, *53*
mimicking pancreatic tail mass, *82*
normal, 129
physiologic herniation of, *253*
Bowel loops
echogenic, mimicking of uterus after hysterectomy, 212, *213*
echogenic, normal ovaries mimicked by, 215
Brain vesicle, primary, first trimester, *254*
Breast, mass biopsy, *186*
Brenner's tumor, 234
Bull's-eye appearance
in metastatic lesions of liver, 44
with splenic candidiasis, 143, *143*

C

Calcifications, splenic, 141, *142*
Calculi, bladder, 11, *122*
Calf hematomas and abscesses, 179, *181*
Candidiasis, splenic, 143, *143*
Carcinoma, gallbladder, 62, *63*
Cavernous hemangioma, 40, *41*
CBD. *See* Common bile duct
Celiac axis, *86*
Cellulitis, 179, *182*
Cervical ectopic pregnancy, 274, *274*
Cervical fibroids, 198
Cervical myoma, *200*
Cervix, 188
Chocolate cyst, 243, *244*
Cholangiocarcinoma, 68, *69*
Cholecystitis, 56–61
acalculous, 60
acute
calculous, 56, *57*
complications of, 58, 60
with increased vascularity, *59*
chronic, 60
gangrenous, 60, *61*
perforated, 60, *61*
Choledochal cysts, 68, *69*
Choledocholithiasis (common bile duct stones), 66, *68*
Cholelithiasis (gallstones), criteria for diagnosis, 47, *51*
Chorio-decidua, 247, *248*
Chorion, 255
Choroid plexus, *257*
Chronic cholecystitis, 60
Chronic hydrocele, *175*
Chronic testicular torsion, 161, *162*
Cirrhosis
late stage, *36*
stages of, 35
"Clean" shadows, 7, 187
Color Doppler systems, 18
Column of Bertin, 92, *94*
Comet-tail artifact, 5, *6*
Common bile duct, normal, 64, *65*
Complete abortion, 263, *264*
Complex cysts
hepatic, *37*

Complex cysts (*cont.*)
ovarian, 215, *219, 220,* 220
renal, *99*
ultrasound description of, 10, *10, 11, 12*
Compressibility, adnexal masses and, 246
Cornual ectopic pregnancy, 268, *272*
bicornuate uterus mimicking, *272*
Coronal plane, 12
Corpus, of uterus, 188
Corpus luteum cyst, 223
Cortical cysts
renal, 96–97
bilateral multiple, 97
Courvoisier's sign, 78
Cranial bones, fetal, *257*
Crown-rump length (CRL) measurement, 250, *251,* 255
Cryptorchidism (undescended testis), 177
Cystadenocarcinomas
ovarian, *232, 233*
pancreatic, 83
Cystadenoma, pancreatic, 83
Cystic masses
kidney, 96
liver, 35
Cyst puncture, 185
Cysts. *See also* Abscesses
benign cortical renal cysts, *98*
chocolate, 243, *244*
complex renal cysts, *99*
ovarian
corpus luteum, 223, *223*
follicular, 223
paraovarian cyst, 224, *225*
theca luteal cyst, 223–224, *224*
parapelvic, 97
splenic, 136, *138, 139*

D
Depth adjustments, image size and, *17*
Depth control, 14
Dermoid cysts
bowel mimicking, *230, 231*
fat-fluid level in, *226*
focal area with shadowing, *229*
located superior to uterus, *230*
solid appearance of, *226*
with peripheral fluid, *227*
with solid component, *227, 228*
Diagnosis
Doppler and, 20
technical factors and accuracy of, 24
Dichorionic-diamniotic twins, 258
Diffuse adenomyosis, 202–203, *203*
Diffuse organ injury, blunt abdominal trauma and, 147
Diffuse pancreatitis, 71
"Dirty" shadows, 7, 187
Displacement of vessels, organs, or structures, abdominal masses and, 187
Dissecting aneurysm, 85
Doppler flow parameters, adjusting, 20
Doppler systems, diagnosis of pathologies and, 20
Double decidual sac sign, 249
Dromedary hump, 92, *94*
Duct of Wirsung, 71
Duplex collecting system, kidney, 96, *96*
DVDs, 23
Dysgerminoma, *235*

E
Eccentric gestational sac
  fibroid uterus and, *273*
  overdistended urinary bladder and, *273*
Echinococcal cysts, 38, *39*
Echoes, creation of, 1
Echogenic, defined, 1
Echogenicity, 24
  abdominal masses and, 187
  abdominal organ evaluation and, 186
  adnexal masses, 245
  myometrium, 214
  ovary evaluation, 245
Echogenic masses, 24
Ectopic pregnancy. *See* Pregnancy(ies), ectopic
Embryo, *251*
Embryonic heart rate, *252*
Emphysematous cholecystitis, 58, 60
Emphysematous pyelonephritis, 113, *118*
Endometrial carcinoma, *206, 207*
  possible associated secondary signs to malignancy, 205
Endometrial hyperplasia, 204, *204*
Endometrial layer, size and echogenicity of, 214
Endometrial measurement, *192*
Endometrial polyps, 204–205, *205, 206*
Endometrial stripe, vagina and, *191*
Endometrioma (chocolate cyst), 243, *244*
Endometriosis, 240, 243
Endometritis, 239, *239*
  with air, *240*
  with fluid, *239*
Endometrium, 189. *See also* Uterus
  measurement of, 191
  menstrual cycle—sonographic appearances of, 191–192
    later proliferative/periovulatory phase, 192
    menstrual phase, 191–192
    proliferative phase, 192
    secretory phase, 192
  postmenopausal, 193
Enlarged prostate, mimicking bladder tumor, *124*
Epidermoid cysts
  splenic, *139*
  testicular, 169, 171, *171*
Epididymis
  body and tail of, 157
  head of, 157
  normal, *159*
Epididymitis, 161, *162,* 163
Epithelial cyst, 35, *37*
Errors, scanning, 24
Extrahepatic biliary dilation, *67*
Extrahepatic biliary obstruction, 64, 66
Extratesticular hematoma, *168*

F
Falciform ligament, 25, *27*
Fallopian tubes, *238,* 238–239
FAST scan. *See* Focused Assessment with Sonography for Trauma (FAST) scan
Fatty liver disease, 31, 33
  decreased echogenicity and mimicking of, *20*
  focal fat infiltration, 33, *34*
  focal fat infiltration and sparing that may mimic liver tumor, 33

Fatty liver disease (*cont.*)
focal fat sparing, 33, *34*
mild (early stage), 31, *32*
moderate (mid stage), 31
severe (late stage), 33, *33*
Fecalith, appendicitis with, *132*
Fetal heart rate, *252*
Fetal limb buds, 252, *254*
Fetal spine, *257*
Fetus, 255
Fibroids
first trimester pregnancy and, 276
uterine, 197–198
categorized by location, 198, 202
Fibroid uterus, eccentric gestational sac caused by, *273*
Fissure for ligamentum venosum, 25, *27*
Floating bowel loops, *184*
Fluid
ascites and collections of, 183
in endometrial cavity, 214
endometritis presenting with, *239*
FAST scan and evaluation of, 148, 151
free, adnexal masses and, 246
in pelvis, *156*
in perihepatic space and Morrison's pouch, *155*
perisplenic, *155*
pleural effusion and collections of, 183
subcapsular hematoma and, *150*
Fluid-filled bowel, free-fluid mimicked by, 151
FMC. *See* Focal myometrium contractions
Focal adenomyomatosis, 56
Focal myometrium contractions, 276
Focal nodular hyperplasia, 40, *42*
Focal pancreatitis, 72
Focal point(s), 14
Focal point settings, resolution and placement of, *19*
Focused Assessment with Sonography for Trauma (FAST) scan, blunt abdominal trauma and, 148, 151
Follicles, ovary evaluation and presence of, 245
Follicular cyst, 223
Foreign bodies
in endometrial cavity, 214
in lower extremities, 180
Free fluid, adnexal masses and, 246
Fundus
gallbladder, *48*
uterus, 188, *194*
Fusiform aneurysm, 85
of abdominal aorta, *89*
with thrombus, *90*

G

Gallbladder. *See also* Bile ducts
carcinoma, 62, *63*
comet-tail artifact and transabdominal sagittal image of, *6*
gallstone casting acoustic shadowing, *8*
hydrops, 58, *58*
main lobar fissure, *48*
normal, *48*
normal sonographic anatomy, 47
pathology of, 47, 52, 56, 58, 60, 62

adenomyomatosis, 56
carcinoma, 62
cholecystitis, 56, 58, 60
cholelithiasis (gallstones), 47
polyps, 52, *56*
porcelain gallbladder, 62, *64*
sludge, 52, *54*
wall thickening, 58
with ascites, 60
in nonfasting patient, *59*
wall thickness measurement of, *49*
Gallstones, 47, *50*
air-filled bowel loops and, 9
bowel mimicking, *53*
conditions mimicking, 47
mobility of, *51*
multiple small, *50*
single large, *50*
surgical clips mimicking, *54*
wall-echo-shadow complex, *51*
Gangrenous cholecystitis, 60, *61*
Gastrointestinal system, 129–135
normal appendix, 130–131
normal bowel, 129–130
pathology, 131–135
appendicitis, 131, *131*
benign and malignant tumors, 133
inflammatory bowel, 133, *134*
intussusception, 131, 133, *133*
mechanical bowel obstruction, 133, *135*
Gastroschesis, 252, *253*
GB. *See* Gallbladder
Gestational age, crown-rump length measurement, 250
Gestational sac
in cervical ectopic pregnancy, 274
eccentric, overdistended urinary bladder and, *273*
at four weeks, *248*
measurements, 247, *249,* 276
Granulomas, splenic, *142*

H

Hard-copy prints, 23
Hartman's pouch, *49*
fold at neck, 47
hCG. *See* Human chorionic gonadotropin
Head
epididymis, 157
pancreas, 71
adenocarcinoma in, *80*
Heart rate, embryonic, *252*
Hemangioma, splenic, 136, *139,* 140
Hematocele, testicular, 167
Hematomas
bladder, 122, *124*
blunt abdominal trauma and, 147–148
common locations of, 147–148, *149, 150, 151, 152, 153*
intrahepatic hematoma, *150*
intraparenchymal, 147
intrasplenic, *149*
pelvis, 148
perihepatic and perisplenic, 147
perinephric and pararenal spaces, 147–148, *151, 152, 153*
subcapsular, 147, *150*
vessels mimicking fluid, *154*
calf, 179, *181*

Hematomas (*cont.*)
extratesticular, *168*
testicular, 163, *167*
Hemoperitoneum
blunt abdominal trauma and, 148
in ectopic pregnancy, *271*
Hemorrhagic cysts
acute, mimicking solid lesion, *221*
sonographic appearances of, 220, *221,* 222
variations of clot retraction, *222*
vascularity outside, *222*
Hepatic artery, 30, *30*
Hepatic neoplasms, malignant, 42, 44
Hepatic veins, *29*
draining into inferior vena cava, *88*
Hepatic vessels, 25–31
diaphragm seen as curvilinear hyperechoic structure, 30
hepatic arteries, 30, *30*
hepatic veins, 25
intrahepatic bile ducts, 30
portal veins, 25, *28*
Reidel's lobe, 30, *31*
Hepatoma (hepatocellular carcinoma)
large, *43*
metastasis and, 42, 44
Hepatomegaly, 31, *32*
Hernia, scrotal, 177, *177*
Heterogeneous ultrasound texture, 4, *5*
Heterotopic pregnancy, 275–276
High-frequency transducer, 23
H-mole. *See* Hydatidiform mole (H-mole)
Homogeneity, 24
abdominal masses and, 187
abdominal organ evaluation and, 186
adnexal masses and, 245
Homogeneous ultrasound texture, 4, *4*
Horseshoe kidney, 92, *95,* 96
Human chorionic gonadotropin, 247, 264, 276, 277
Hydatidiform mole (H-mole), 263, *265, 266*
Hydrocele, 172
bilateral, *175*
chronic, *175*
Hydronephrosis, 110, 113, *114–115*
with hydroureter, *116*
renal calculi with, *110*
Hydrops, gallbladder, 58, *58*
Hydrosalpinx, 239–240
Hydroureter, hydronephrosis with, *116*
Hyperechoic, *3,* 24
defined, 1
liver areas, *3*
Hypernephroma (renal cell carcinoma), 103, 106
Hyperplasia, endometrial, 204
Hypoechoic, *3,* 24
defined, 1
mass within right lobe of liver, *2*
Hysterectomy, bowel loop mimicking uterus after, 212, *213*

I

IMA. *See* Inferior mesenteric artery
Image quality
poorly visualized far field, *19*

suboptimal, misdiagnosis and, 18
Image recording, methods of, 23–24
Image size
depth adjustments and, *17*
small, difficulties with liver parenchyma evaluation and, *18*
Incomplete abortion (retained products of conception), 261, *262,* 263, *263*
Infarction, splenic, 141, *142*
Inferior mesenteric artery, 84
Inferior vena cava, 84, *87*
aorta *vs.,* on sonography, 84–85
gallbladder, *48*
hepatic veins draining into, *88*
normal sonographic anatomy, 84
Inferior vena cava tumor thrombus, 106
Inflammatory bowel, 133, *134*
Inflammatory diseases of the liver, 35, 38, *39,* 40
Inhomogeneous ultrasound texture, 4, *5*
Instrumentation, 12, 14, 18
Interstitial (intramural) myoma, *201*
Interstitial uterine fibroids, 198
Intrahepatic bile ducts, 30
normal, *65*
Intrahepatic biliary dilation, *67*
Intrahepatic biliary obstruction, 66, *66*
Intrahepatic hematoma, *150*
Intrasplenic hematoma, *149*
Intratesticular cyst, 169
Intratesticular hematoma, *167*
Intrauterine contraceptive devices, 208–210, *209*
abnormally positioned, *210, 211*
complications of, 210
malposition, 210, *210, 211*
nonvisualizataion within uterus, 210
perforation, 210, *211*
in situ, *208*
types of, 208
Intussusception, 131, 133, *133*
Isoechoic
defined, 1
kidney to liver, *3*
Isthmus, of uterus, 188
IUCDs. *See* Intrauterine contraceptive devices

J

Junctional parenchymal defect, 92, *95*

K

Keyboard, 12
Kidneys. *See also* Renal pathology
hematoma obscuring, *153*
normal sonographic anatomy of, 92, *93*
normal variants and congenital anomalies, 92, 96
column of Bertin, 92, *94*
dromedary hump, 92, *94*
duplex collecting system, 96, *96*
horseshoe kidney, 92, *95,* 96
junctional parenchymal defect, 92, *95*
pelvic kidney, 96, *97*
Krukenberg tumors, 234, *236*

L
Leiomyoma
with calcified ring, *199*
with focal calcifications, *199*
of uterus, 197–198, *198*
Ligamentum teres, 25
Ligamentum venosum, fissure for, 25, *27*
Linear transducer display, *22*
Linear transducers, 21, *21,* 22
Lipomas
liver, 42, *43*
renal, 103
Liver, 25–46
benign tumors of, 40–42
enhancement artifact and left lobe of, *7*
homogeneous texture of, *4*
hypoechoic mass within right lobe of, *2*
inhomogeneous texture of, *5*
lobes of, *26*
metastasis in, *45*
mild fatty infiltration of, *32*
normal, *26*
normal sonographic anatomy of, 25–31
hepatic vessels, 25–31
pathology of, 31–46
amebic abscess, 38, 40
benign liver tumors, 40–42
cirrhosis, 35
cystic masses, 35
echinococcal cysts, 38
fatty liver, 31, 33
hepatomegaly, 31
inflammatory diseases (abscesses), 35
malignant hepatic neoplasms, 42–46
pyogenic abscess, 38
severe fatty infiltration of, *33*
Liver cell adenoma, 42
Lobes, of liver, *26*
Location
abdominal masses and, 187
abdominal organ evaluation and, 186
adnexal masses and, 245
ovary evaluation and, 245
uterine fibroids and, 198, 202
uterus and, 193, *194, 195,* 214
Lower extremity pathology, 179–187
calf hematomas and abscesses, 179
cellulitis, 179, *182*
foreign bodies, 180
popliteal artery aneurysm, 179
popliteal fossa cyst (Baker's cyst), 179, *180*
pseudoaneurysms, 179–180, *182*
Low-frequency transducer, 22
Lymphadenopathy
adnexal masses and, 246
endometrial carcinoma and, 205
splenic, 144, *145, 146*
Lymph nodes, 144–146
enlarged, 245
lymphadenopathy, 144, *145*
forming mantle, *146*
normal, 144
Lymphoma
splenic, 143
testicular, *174*

M
Main lobar fissure, liver, 25
Malignant ascites, *184*
Malignant hepatic neoplasms, 42, 44

Malignant neoplasms of kidney
renal cell carcinoma (hypernephroma), 103, 106
transitional cell carcinoma, 106, *107*
Malignant tumors
bladder, 122, *123*
bowel, 133
ovarian, 229, 233–234
Mass biopsy, 185
breast, *186*
Masses
in endometrial cavity, 214
ultrasound description of, 9–11
complex cyst, 10, *10, 11, 12*
simple cyst, 9, *9*
solid mass, 10–11
Mechanical small bowel obstruction, 133, *135*
Mediastinum testis, *158*
Medical renal disease
acute, 116, *120*
chronic, 116, *120*
Medium-frequency transducer, 23
Medullary sponge kidney
nephrocalcinosis secondary to, *112*
sonographic findings when associated with nephrocalcinosis, 110
Menstrual phase, menstrual cycle, 191–192
Menstruating female, ovarian mean dimensions for, 215
Metastasis
hepatoma and, 42, 44
liver, *45*
splenic, 143, *144*
Metastatic lesions, liver, features of, 44, *44*
Microlithiasis, within testicle, 177, *178*
Missed abortion (retention of dead embryo), 261, *262*
M-mode tracing
documenting, 276
ectopic pregnancy and, 264
Monochorionic-diamniotic twins, 259, *259*
Morrison's pouch
examining for fluid, 148, *155*
fluid in perihepatic space and, *155*
Mucinous cystadenoma, 225
Murphy's sign, 58
acalculous cholecystitis and, 60
acute calculous cholecystitis and, 60
Myomas
cervical, *200*
interstitial, *201*
submucosal, *200*
subserosal, *201*
uterine, 197–198
Myometrium, 189
echogenicity of, 214

N

Nabothian (inclusion) cyst, *194,* 210, *212*
Neck, of gallbladder, *48*
Nephrocalcinosis, secondary to medullary sponge kidney, *112*
Nodular adenomyosis, 203

O

Obstructed urinary bladder, 245
Obturator internus muscle, *218*
Omphalocele, 252, *253*
Oncocytoma, 103, *103*

Orchitis
  diffuse, 163, *164*
  focal, 163
Organ displacement, adnexal masses and, 246
Orientation, uterine, 214
Ovarian carcinoma, ascites and, *207*
Ovarian cysts
  complex, 215, *219*
  corpus luteum cyst, 223, *223*
  follicular cyst, 223
  paraovarian cyst, 224, *225*
  simple, 215, *219*
  theca luteal cyst, 223–224, *224*
Ovarian masses, first trimester pregnancy and, 276
Ovarian torsion, 234–238, *237*
Ovaries
  dominant follicle, transvaginal and transabdominal images, *217*
  evaluation, 245
  mean dimensions of, 215
  measurement of, *218*
  normal sonography of, 215
  obturator internus muscle, *218*
  pathology of, 215, 220–238
    benign and malignant solid ovarian tumors, 233–234
    benign cystic teratoma (dermoid cyst), 225, *226, 227, 228,* 229
    corpus luteum cyst, 223, *223*
    follicular cyst, 223
    hemorrhagic cyst, 220, *221,* 222
    mucinous cystadenoma, 225
    ovarian cyst (complex), 215, *219,* 220, *220*
    ovarian cyst (simple), 215, *219*
    ovarian torsion, 234, *237,* 238
    paraovarian cyst, 224, *225*
    serous and mucinous cystadenocarcinoma, 229, *232,* 233
    serous cystadenoma, 224
    theca luteal cyst, 223–224, *224*
  transabdominal sagittal image of, *216*
  transvaginal sagittal image of, *216*
Overall gain control, 12

P
PACS. *See* Picture Archiving and Communication System
Pancreas, 71–83
  with fluid-filled duodenum, *74*
  normal, sagittal views of, *73*
  normal sonographic anatomy of, 71, *72*
  pathology of, 71–83
    acute pancreatitis, 71, 72, *75*
    adenocarcinoma, 76, *76,* 78, *81*
    chronic pancreatitis, 76, *76, 79*
    cystadenoma and cystadenocarcinomas, 83
    diffuse pancreatitis, 71
    focal pancreatitis, 72
Pancreatic ascites, 76, *78*
Pancreatic duct
  main, *74*
  mimics of, *75*

Pancreatic mass,
peripancreatic nodes
mimicking, *81*
Pancreatic tail mass, bowel
mimicking, *82*
Pancreatitis
acute, *75*
complications of, 72, 76
chronic, *76, 79*
pseudocyst formation and, *77*
Paraovarian cysts, 224, *225*
Parapelvic cysts, 97
Parapelvic renal cysts, *100*
Pararenal hematoma, *153*
Parity, uterine measurements
and, 189
Pathology, indication of, 24
Pedunculated serous myoma,
202
Pedunculated serous uterine
fibroids, 198
Pelvic abscesses, *244*
Pelvic inflammatory disease,
239–240
endometritis, 239, *239*
hydrosalpinx/pyosalpinx,
239–240
tubo-ovarian abscess, 240
Pelvic kidney, 96, *97*
gynecological mass
mimicked by, 243
Pelvic masses,
nongynecological, 243,
245
Pelvic sonography, approaches
to, 188
Pelvis
fluid in, *156*
post hysterectomy,
evaluation of, 212
Perforated cholecystitis, 60, *61*
Perimetrium, 189
Perinephric hematoma, *151,*
152
Periovulatory phase, menstrual
cycle, 192
Peripancreatic nodes,
pancreatic mass
mimicked by, *81*
Perisplenic fluid, *155*
Peristalsis
abdominal masses and,
187
adnexal masses and, 246
Phyrgian cap, *49*
fold at fundus, 47
Picture Archiving and
Communication System,
23–24
Placenta, early, *256*
Pleural effusion, *185*
fluid collection, 183
Pneumobilia (air in biliary
tree), 68, *70*
Polycystic liver disease, 35, *38*
late-stage, *102*
Polyps
endometrial, 204–205, *205,*
206
gallbladder, 52, *56*
Popliteal artery aneurysm,
179
Popliteal fossa cyst (Baker's
cyst), 179, *180*
Porcelain gallbladder, 62, *64*
Portal vein, *29*
branches of, *28*
gallbladder, *48*
main, *28*
tumor/thrombus in, *46*
Posterior acoustic
enhancement, adnexal
masses and, 245
Posterior enhancement,
abdominal masses
and, 187
Post hysterectomy pelvis,
evaluation of, 212

Postmenopausal endometrium, asymptomatic female, 193
Postmenopausal female, ovarian mean dimensions for, 215
Post-void bladder residual volume, calculation of, *128*
Power Doppler systems, 18
Pregnancy(ies)
  abdominal, 274–275
  abnormal first trimester, 259–264
    blighted ovum (anembryonic gestational sac), 259, *261*
    complete abortion, 263, *264*
    hydatidiform mole (H-mole), 263–264, *265, 266*
    incomplete abortion (retained products of conception), 261, *262,* 263, *263*
    missed abortion (retention of dead embryo), 261, *262*
    subchorionic hemorrhage, 259, *260*
  early, transvaginal approach in, 247
  ectopic, 264, 267–273, 277
    adnexal ring in, *269*
    cervical ectopic, 274, *274*
    cornual ectopic, 268, *272*
    hemoperitoneum, *271*
    intrauterine findings in, 267
    leaking or ruptured, extrauterine findings in, 268
    ovarian cyst mimicking adnexal ring in, *270*
    ring of fire in, *270*
    sites of, 267
    sonographic appearance, 264
    unruptured, extrauterine findings in, 268
  findings indicating poor outcome, 276–277
  gestational sac at four weeks, *248*
  heterotopic, 275–276
  masses seen in first trimester, ovarian and uterine, 276
  multiple, 258–259
    dichorionic–diamniotic twins, 258
    monochorionic–diamniotic twins, 259
  sonographic visualization of early gestation, 247–257
    week 4, 247
    week 8, 252
    week 9, 252
    week 10, 255
    week 11, 255
    week 12, 255
  sonographic visualization of normal early gestation, 247–257
Prepubertal female, ovarian mean dimensions for, 215
Proliferative phase, menstrual cycle, 192
Prostate, enlarged, mimicking bladder tumor, *124*
Pseudoaneurysms, 179–180, *182*
Pseudocysts, pancreatic, 72, 76, *77*
Pseudogestational sac, 267, *267*
Pyelonephritis, 113
  acute, *117*
Pyocele, testicular, *166*

Pyogenic abscess, 38, *39*
Pyonephrosis, 113
Pyosalpinx, 239–240, *241*

R

Recording images, methods of, 23–24
Reflected sound waves, 1
Reidel's lobe, 30, *31*
Renal calculi, 106, *109,* 110
  with hydronephrosis, *110*
  ureteral stent mimicking, *111*
Renal cell carcinoma, 103, *104–105,* 106
Renal infections, 113, 116
  enphysematous pyelonephritis, 113
  pyelonephritis, 113
  pyonephrosis, 113
  renal tuberculosis, 116, *119*
  xanthoygranulomatous pyelonephritis, 113
Renal mass, adrenal myelolipoma mimicking, *107*
Renal pathology, 96–118
  adult polycystic kidney disease, 100
  benign neoplasms, 100–103
    angiomyolipoma, 100, 103
    lipomas, 103
    oncocytoma, 103
  cystic masses, 96–97
  hydronephrosis, 110, 113
  malignant neoplasms, 103–106
    renal cell carcinoma, 103, *105,* 106
    transitional cell carcinoma, 106
  medical renal disease, 116
    acute, 116
    chronic, 116
  medullary sponge kidney, 110
  parapelvic cysts, 97–99
  renal calculi, 106, 110
  renal infection, 113–116
    emphysematous pyelonephritis, 113
    pyelonephritis, 113
    pyonephrosis, 113
    renal tuberculosis, 116
    xanthoygranulomatous pyelonephritis, 113
Renal tuberculosis, 116, *119*
Resolution
  focal point settings placement and, *19*
  loss of, in posterior aspect of liver, *20*
Retroperitoneal masses, 245
Retroverted/retroflexed uterine position, 193, *194, 195,* 214
Reverberation (ring down) artifact, 4–5, *6*
Ring of fire, in ectopic pregnancy, *270*
Ruptured ectopic pregnancy, 264
  extrauterine findings in, 268

S

Saccular aneurysm, of abdominal aorta, *89*
Sagittal plane, 12, *13*
Scanning errors, 23
Scrotal abscesses, 163, *165*
Scrotal cysts, 169–171
  epidermoid cysts, 169, 171, *171*
  intratesticular cysts, 169
  spermatocele, 171, *172*
  tunica albuginea cysts, 169, *170*
Scrotal hernia, 177, *177*
Scrotum, normal sonography of, 157
Secondary yolk sac, *250*

Secretory phase, menstrual cycle, 192
Sector transducers, *21,* 22
Seminoma, *173*
Septate uterus, 193, 195, *196*
Septation within gallbladder, seen as linear hyperechoic structure, 47
Serous and mucinous cystadenocarcinoma, 229, *232,* 233
Serous cystadenoma, 224
Sertoli-Leydig cell tumor, 234
Serum beta hCG levels, 247, 264, 276, 277
Shadowing
  abdominal masses and, 187
  adnexal masses and, 245
Shadowing artifact, 7, *8,* 9
Shape
  abdominal masses and, 187
  abdominal organ evaluation and, 186
  adnexal masses and, 245
  uterine, 214
Simple cysts
  ovarian, 215, *219*
  ultrasound description of, 9, *9*
Size
  abdominal masses and, 187
  abdominal organ evaluation and, 186
  adnexal masses and, 245
  ovary evaluation and, 245
  uterus examination and, 214
Slice thickness artifact, 9
Sludge, in gallbladder, 52, *54*
SMA. *See* Superior mesenteric artery
Small bowel obstruction, mechanical, 133, *135*
Solid mass, ultrasound description of, 10–11, *13*
Sonohysterography, 202
Sound waves, 1
Spectral Doppler systems, 18
Spermatocele, 171, *172*
Spine, fetal, *257*
Spleen, 136–143
  accessory, *137*
  normal sonography of, 136, *137*
  pathology of, 136–143
    abscess, 140, *140, 141*
    atrophy, 136
    candidiasis, 143, *143*
    hemangioma, 136, *139,* 140
    infarction, 141, *142*
    malignant tumors of, 143
    splenic calcifications, 141, *142*
    splenic cyst, 136, *138, 139*
    splenomegaly, 136, *138*
Splenic cysts, 136, *138, 139*
Splenic metastasis, 143, *144*
Splenic rupture, 147, *148*
Splenomegaly, 136, *138*
Staghorn calculi, 106, *109*
Stomach
  mimicking splenic abscess, *141*
  normal, *129*
Stomach leiomyoma, *134*
Subcapsular hematoma, *150*
Subchorionic hemorrhage, 259, *260*
Submucosal myoma, *200*
Submucosal uterine fibroids, 198
Subseptate uterus, 193, 195
Subserosal myoma, *201*
Subserous uterine fibroids, 198
Superior mesenteric artery, 84, *87*

Surgical clips
postcholecystectomy, mimicking of gallstones and, 47, *54*

T

Tail
of epididymis, 157
of pancreas, 71
adenocarcinoma, *80*
Testes
normal sonography of, 15, *158*
pathology of, 160–169
acute testicular torsion, 160–161
chronic testicular torsion, 161
epididymitis, 161, *162,* 163
focal orchitis, 163
inflammatory conditions, 161, 163
orchitis, 163, *164*
pyocele, *166*
testicular trauma, 163–167
hematocele, 167
hematoma, 163, *167*
other sonographic findings in, 167
testicular rupture, 167
undescended, 177
vasculature, 157, 160, *160*
Testicle, normal, *158*
Testicular abscesses, 163, *165*
Testicular lymphoma, *174*
Testicular rupture, 167
Testicular torsion, 160–161, *161*
acute, 160
chronic, 161, *162*
partial, 161
Testicular tumors, 171–172, *173*
Testicular vascular flow, normal, *160*
Theca luteal cyst, 223–224
Theca lutein cyst, 264, *266*
Thecoma, *236*
Thoracentesis, 185
Thrombus
fusiform aneurysm with, *90*
in portal vein, *46*
Time gain compensation, 13, *14*
with fair gain greatly increased, *15*
with near gain greatly decreased, *16*
with overall gain greatly decreased, *15*
with overall gain greatly increased, *14*
Torsion
appendix testis, 161
testicular
acute, 160
chronic, 161, *162*
partial, 161
Transabdominal approach
for pelvic sonography, 188
for uterine examination, 214
for uterus with large fibroid in first trimester pregnancy, 276
Transducers, abdominal masses and compressibility with, 187. *See also* Ultrasound transducers
Transitional cell carcinoma, of kidney, 106, *107, 108*
Transvaginal approach
in early pregnancy, 247, 276
for pelvic sonography, 188
for uterine examination, 214
Transvaginal scanning, contraindications for, 188
Transvaginal transducers, *21*

Transverse plane, 12, *13*
Tubo-ovarian abscess, 240, *242, 243*
Tumefactive bile, *55*
Tumors
liver, benign, 40–42
ovarian, benign
benign cystic teratoma (dermoid cyst), 225, *226, 227, 228, 229, 230*
mucinous cystadenoma, 225
serous cystadenoma, 224
ovarian, benign and malignant, 233–234
ovarian, malignant, serous and mucinous cystadenocarcinoma, 229, 233
in portal vein, *46*
testicular, 171–172
Tunica albuginea cyst, 169
with echoes, *170*
Twins
dichorionic-diamniotic, 258
monochorionic-diamniotic, 259, *259*
twin gestation with dividing membrane, *258*

U
UB. *See* Urinary bladder
Ultrasound
artifacts, 4–5, 7, 9
acoustic enhancement, 5, 7, *7*
attenuation, 7, *8*
cause of, 4
comet-tail, 5, *6*
reverberation, 4–5, *6*
shadowing, 7, *8,* 9
slice thickness, 9
description of masses, 9–12
complex, 10, *10, 11, 12*
simple cyst, 9, *9*
solid mass, 10–12, *12*
nomenclature, 1, *2*
sectional views, 12
texture, 4
Ultrasound-guided procedures, 183, 185
Ultrasound machine, functions of, 12, 16, 20
Ultrasound transducers
frequency, 22–23
high-frequency, 23
low-frequency, 23
medium-frequency, 23
types of, 20–22
linear transducers, 20, *21*
sector transducers, *22,* 22
transvaginal, *21*
Ultrasound waves, defined, 1
Umbilical cord, *256*
Unruptured ectopic pregnancy, 264
extrauterine findings in, 268
Ureter, dilated, 245
Ureteral jets, *121*
Ureteral stent, mimicking renal calculi, *111*
Ureterocele, 125, *127*
Urinary bladder, 118–128
anechoic distended, *2*
bladder pathology, 118, 122–128
benign and malignant tumors, 122, *123*
bladder diverticulum, 122, 125, *126*
calculi, 118, *122*
hematomas, 122, *124*
ureterocele, 125, *127*
urinary retention, 125, *127*

distended, reverberation artifact and, *6*
indentation of, adnexal masses and, 246
normal sonographic anatomy, 118, *121*
overdistended, eccentric gestational sac and, *273*
Urinary retention, 125, *127*
Uterine didelphys, 195, 197, *197*
Uterine divisions, *189*
Uterine masses, first trimester pregnancy and, 276
Uterine measurements, *190*
Uterus, 188–214. *See also* Endometrium
approaches in examination of, 188, 214
bicornuate, mimicking cornual ectopic pregnancy, *272*
common congenital variations seen on ultrasound, 193–197
bicornuate uterus, 195, *196*
septate/subseptate uterus, 193, 195, *196*
uterine didelphys, 195, 197, *197*
dermoid cysts located superior to, *230*
fibroid, eccentric gestational sac caused by, *273*
layers of, 189
location and positions of, 193, *194, 195*
nonvisualization of intrauterine contraceptive devices within, 210
normal sonography of vagina and, 188–189
obturator internus muscle, *218*
pathology, 197–213
adenomyosis, 202–203
endometrial carcinoma, 205, *206, 207*
endometrial hyperplasia, 204
endometrial polyps, 204–205, *205, 206*
evaluation of post hysterectomy pelvis, 212
intrauterine contraceptive devices, 208–210
leiomyoma (myoma, fibroid), 197–198, *198, 199, 200, 201,* 202
Nabothian (inclusion) cyst, 210, 212
transabdominal transverse image of pelvis and, *242*
transvaginal coronal image of, *241*

V

Vagina
endometrial stripe and, *191*
midline echogenic stripe in, 189
Vaginal cuff
post hysterectomy evaluation of, 212
of post hysterectomy patient, *213*
Valves of Heisters, mimicking of gallstones and, 47
Varicoceles, 172, *176*
Vascular access, 185
Vascularity
abdominal masses and, 187
abdominal organ evaluation and, 186

Vascularity (*cont.*)
adnexal masses and, 246
Vitelline duct, 252

W

WES sign
chronic cholecystitis and, 60
gallbladder and, *52*
gallstones and, 47, *51*

X

Xanthoygranulomatous pyelonephritis, 113

Y

Yolk sac, 255, 276
measurements, 249
secondary, *250*
Yolk stalk, 252, *253*

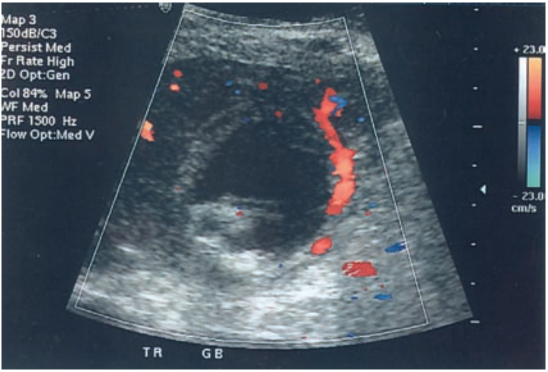

Figure 3-16 Acute cholecystitis with increased vascularity. Transverse view of the gallbladder with increased vascularity around lateral wall of the gallbladder on color Doppler.

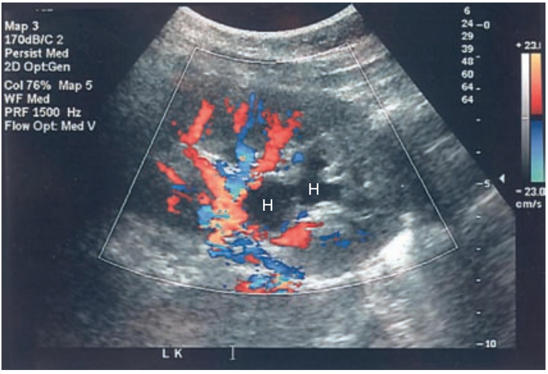

Figure 6-25A Hydronephrosis. Grade 1 hydronephrosis—small anechoic areas within collecting system (H) represents mild hydronephrosis. Color Doppler proves that they are not vascular structures.

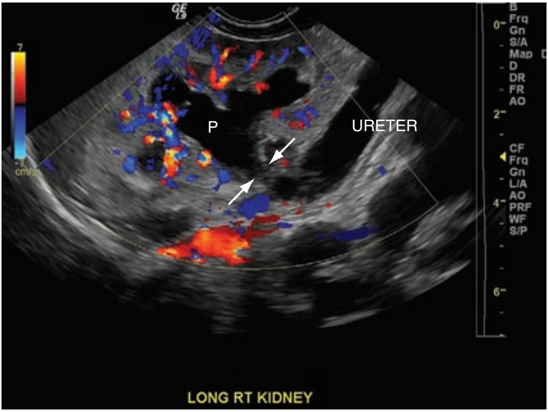

Figure 6-26 Hydronephrosis with hydroureter. Longitudinal sonogram showing dilated renal pelvis (P) and dilated tortuous proximal and mid ureter. Echoes arising from scanning artifacts (arrows) are seen due to tortuosity of the ureter.

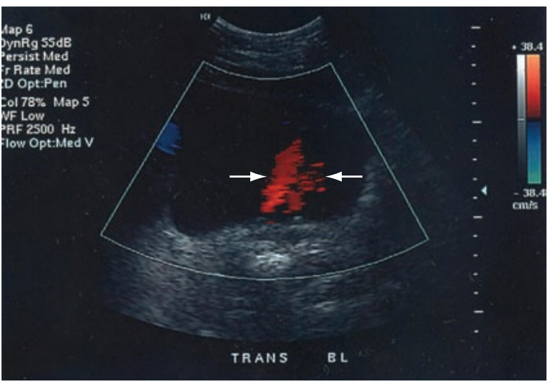

Figure 6-32 Ureteral jets. Color Doppler demonstrates ureteral jets (arrows) within the bladder indicating nonobstruction of the ureters.

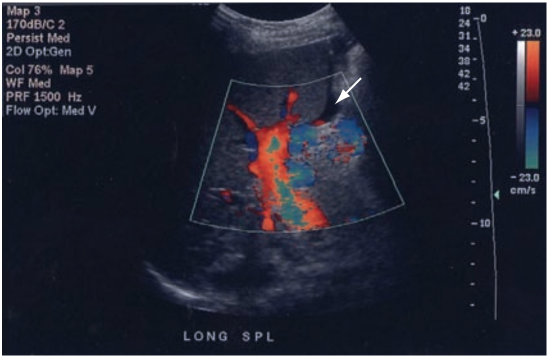

Figure 9-9B Vessels mimicking fluid. Color Doppler confirms anechoic structure to be a splenic vessels. However, a small anechoic area (arrow) without Doppler flow is seen under the spleen. This represents a minimal amount of free fluid.

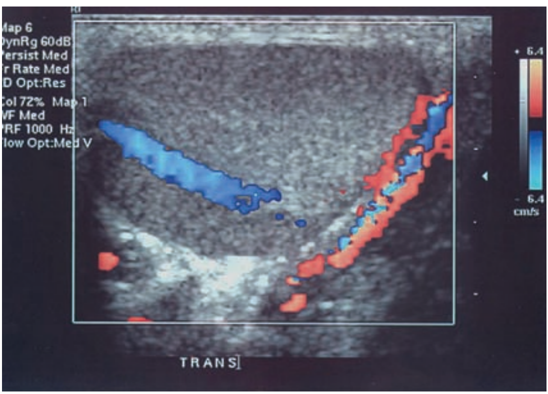

Figure 10-5 Normal testicular vascular flow. Color Doppler shows normal flow both within testicle and on its periphery.

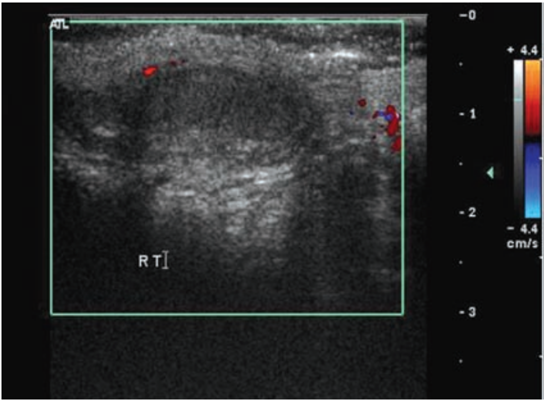

Figure 10-7 Chronic torsion. Testis is small and hypoechoic. There is absence of flow within testicular parenchyma on color Doppler.

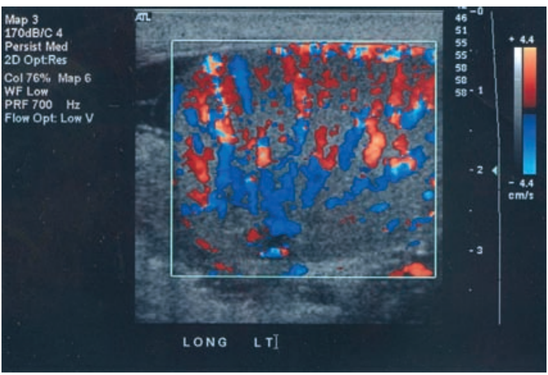

Figure 10-9B Diffuse orchitis. Orchitis in a different patient demonstrates increased Doppler flow.

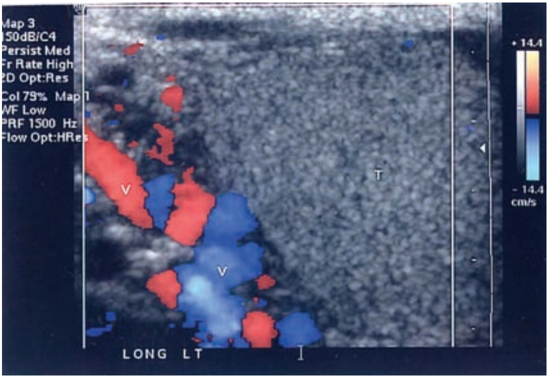

Figure 10-24B Varicoceles. Dilated veins demonstrate flow on color Doppler.

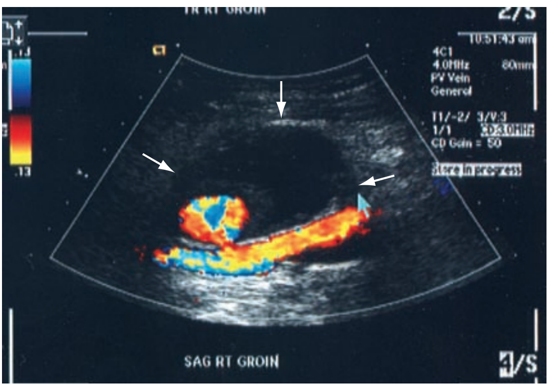

Figure 11-4 Pseudoaneurysm. Color Doppler of femoral artery shows flow (arrows) entering anechoic pseudoaneurysm.

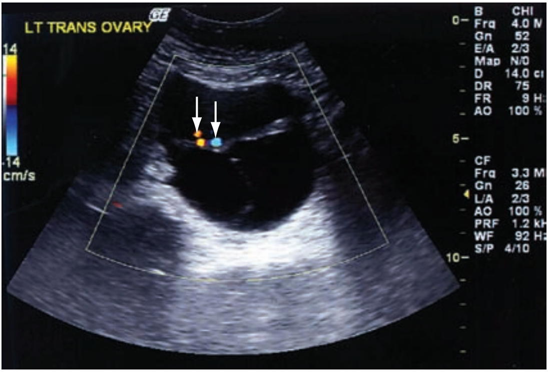

Figure 14-21A Cystadenocarcinoma. Color Doppler demonstrating internal vascularity (arrows) within a complex mass.

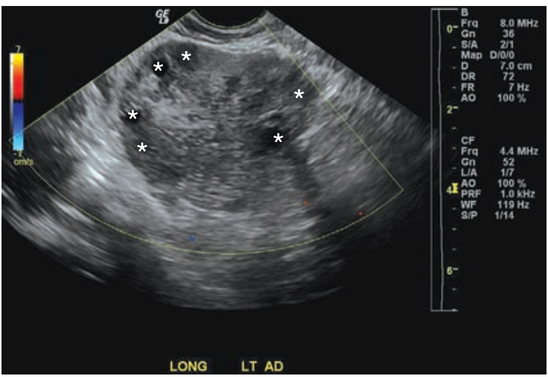

Figure 14-26B Ovarian torsion. Transvaginal sagittal image of an enlarged ovary with multiple cortical follicles (*).

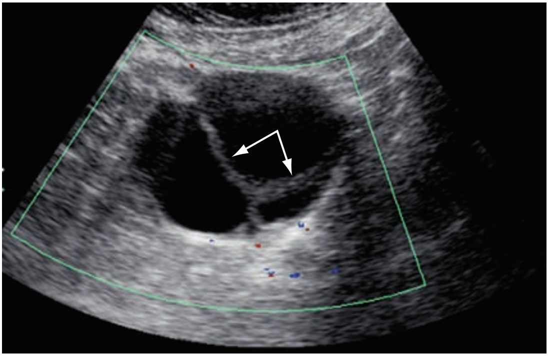

Figure 15-27 Theca lutein cyst. Transabdominal image in a patient with a hydatidiform mole demonstrates a theca lutein cyst with internal septations (arrows). There was no flow on color Doppler exam.

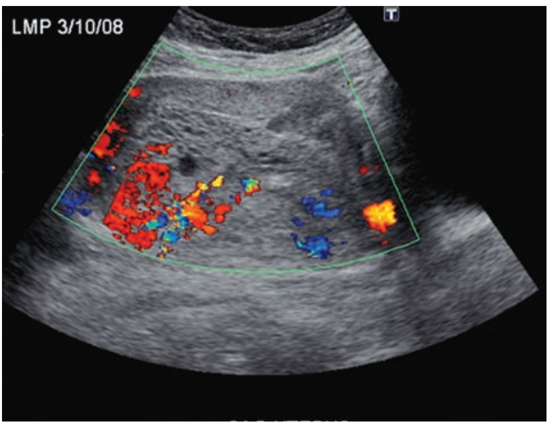

Figure 15-25B Hydatidiform mole. Image demonstrates increased color Doppler flow within the uterine cavity. This patient was 12-weeks pregnant on clinical exam.

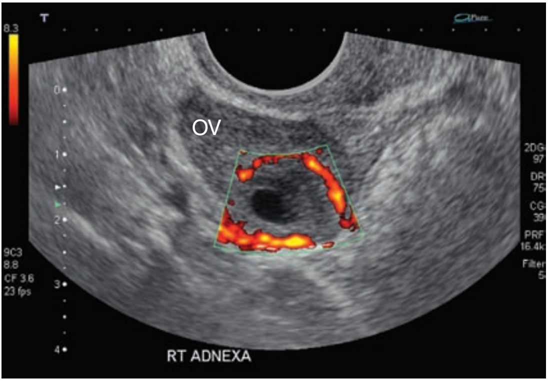

Figure 15-30 Ring of fire in ectopic pregnancy. Transvaginal view showing an ectopic pregnancy with increased vascularity on color Doppler. Ovarian tissue (OV) is seen anteriorly.

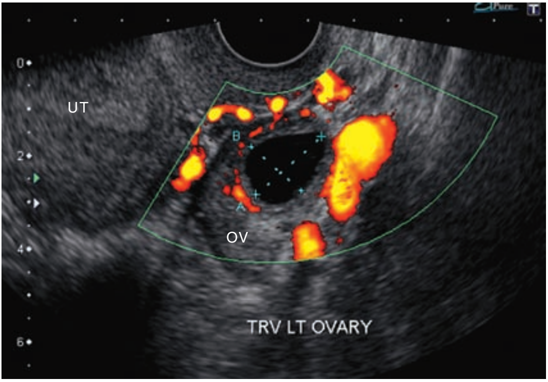

Figure 15-31 Ovarian cyst mimicking adnexal ring in ectopic pregnancy. Endovaginal view demonstrates an ovarian cyst (within calipers) with color Doppler flow partially around the ovary (OV). This appearance can mimic an adnexal ring seen in ectopic pregnancy. UT—uterus.

Dunstan Abraham
Cynthia Silkowski
Charles Odwin

Emergency Medicine Sonography

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